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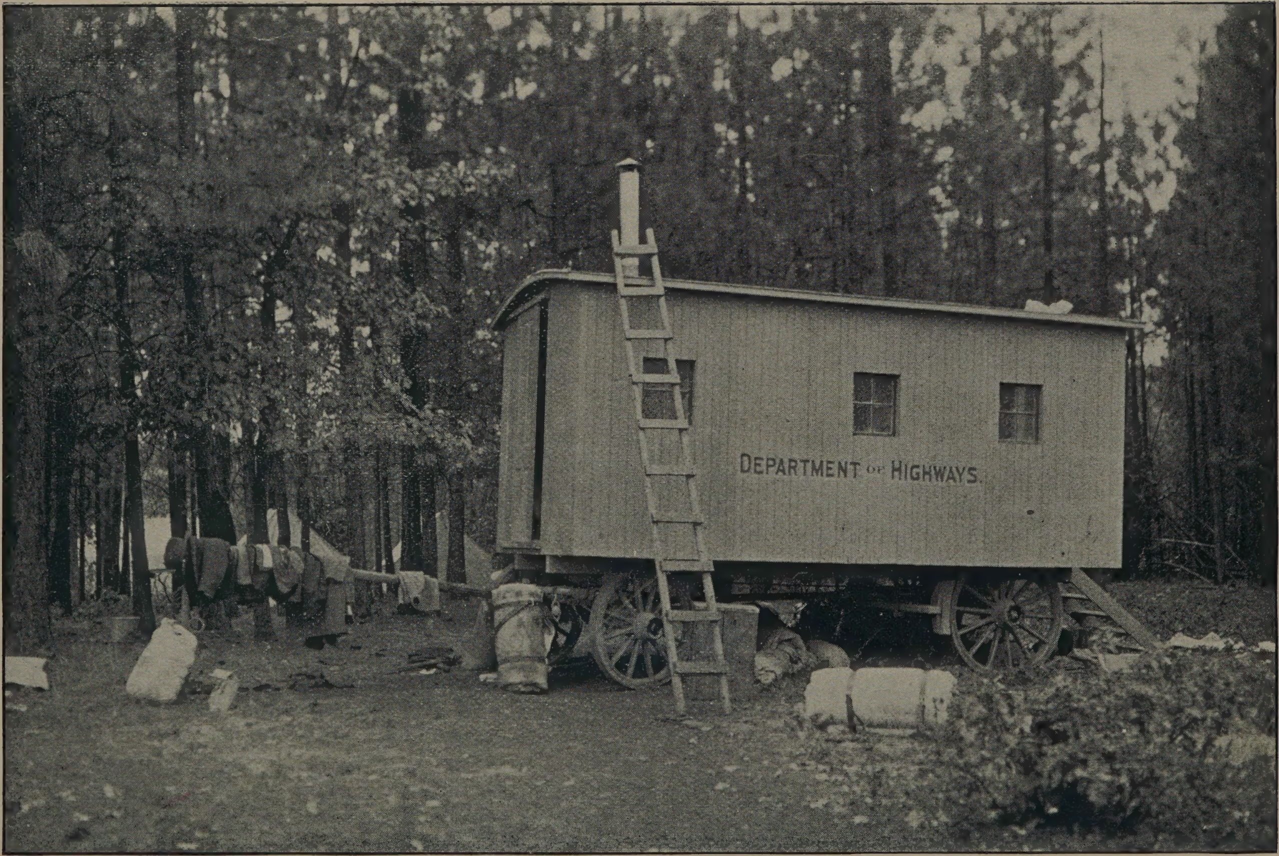

Cook Wagon and Camp Equipage, Department of Highways.

95-06743-1

BIENNIAL REPORT

OF THE

DEPARTMENT OF HIGHWAYS

DECEMBER, 1900.

J. L. MAUDE,
COMMISSIONER.

SACRAMENTO:
A. J. JOHNSTON, : : : : SUPERINTENDENT STATE PRINTING.
1900.

State Capitol, Sacramento, California,
Department of Highways,
November 20, 1900.

To His Excellency Henry T. Gage,
Governor of the State of California:

Sir: I herewith transmit to you the Report of the Department of Highways, covering the work of the Department from May 25, 1899, to November 1, 1900, under authority of law; and, appended thereto, the Report of the Lake Tahoe State Wagon Road Commissioner.

Very respectfully,

J. L. MAUDE,
Highway Commissioner.

Attest: C. W. Vickrey, Secretary.

REPORT OF THE DEPARTMENT OF HIGHWAYS.

INTRODUCTORY.

ANCIENT ROADS.

Since mankind constructed society and became distributed over countries, roads have been a necessity. Although the Roman roads remain with us to-day as monuments to an empire that at one time had sway over the then known world, the Egyptians, the Israelites, and the Greeks preceded them in the construction of highways, and it remained for Carthage to build the first paved roads, connecting that great commercial city with Rome. All over the world, through Europe, Asia, and Africa, wherever the Roman legions went with the all-conquering eagle, they left in their wake a path of good roads.

The main Roman roads were designated by them as military highways, and connected the chief strategic points for the movements of an army, and it is a literal fact that during the time of the Cæsars "all roads led to Rome." In Italy, Switzerland, France, Germany, the British Isles, and other countries of Europe, vestiges of the old military highways of the Roman Empire still remain, and the engineering skill shown in traversing the lofty summits of the Alps and Pyrenees is well worthy of emulation by the modern road-builder.

Turning to our own continent, we find a most interesting account of the great roads of the Incas of Peru in the "History of the Conquest of Peru," by William H. Prescott. He says:

> Those who may discredit the accounts of (ancient) Peruvian industry will find their doubts removed on a visit to the country. The traveler still meets, especially in the central regions of the table-land, with memorials of the past, remains of temples, palaces, fortresses, terraced mountains, great military roads, aqueducts, and other public works, which, whatever degree of science they may display in their execution, astonish him by their number, the massive character of the materials, and the grandeur of the design. Among them, perhaps the most remarkable, are the great roads, the broken remains of which are still in sufficient preservation to attest their former magnificence. There were many of these roads, traversing different parts of the kingdom; but the most considerable were the two which extended from Quito to Cuzco, and, again diverging from the capital, continued in a southern direction toward Chili.
>
> One of these roads passed over the grand plateau, and the other along the lowlands

on the borders of the ocean. The former was much the more difficult achievement, from the character of the country. It was conducted over pathless sierras buried in snow; galleries were cut for leagues through the living rock; rivers were crossed by means of bridges that swung suspended in the air; precipices were scaled by stairways hewn out of the native bed; ravines of hideous depth were filled up with solid masonry; in short, all the difficulties that beset a wild and mountainous region, and which might appall the most courageous engineer of modern times, were encountered and successfully overcome. The length of the road, of which scattered fragments only remain, is variously estimated, from fifteen hundred to two thousand miles; and stone pillars, in the manner of European milestones, were erected at stated intervals of somewhat more than a league, all along the route. Its breadth scarcely exceeded twenty feet. It was built of heavy flags of freestone, and in some parts, at least, covered with a bituminous cement, which time has made harder than the stone itself. In some places, where the ravines had been filled up with masonry, the mountain torrents, wearing on it for ages, have gradually eaten a way through the base, and left the superincumbent mass—such is the cohesion of the materials—still spanning the valley like an arch!

* * * * * * * * * * * *

The other great road of the Incas lay through the level country between the Andes and the ocean. It was constructed in a different manner, as demanded by the nature of the ground, which was for the most part low and much of it sandy. The causeway was raised on a high embankment of earth, and defended on either side by a parapet or wall of clay; and trees and odoriferous shrubs were planted along the margin, regaling the sense of the traveler with their perfumes, and refreshing him by their shades.

* * * * * * * * * * * *

The care of the great roads was committed to the districts through which they passed, and a large number of hands was constantly employed under the Incas to keep them in repair. This was the more easily done in a country where the mode of traveling was altogether on foot; though the roads are said to have been so nicely constructed, that a carriage might have rolled over them as securely as on any of the great roads of Europe. Still, in a region where the elements of fire and water are both actively at work in the business of destruction, they must, without constant supervision, have gradually gone to decay. Such has been their fate under the Spanish conquerors, who took no care to enforce the admirable system for their preservation adopted by the Incas. Yet, the broken portions that still survive, here and there, like the fragments of the great Roman roads scattered over Europe, bear evidence to their primitive grandeur, and have drawn forth the eulogium from a discriminating traveler, usually not too profuse in his panegyric, that "the roads of the Incas were among the most useful and stupendous works ever executed by man."

CONDITIONS IN CALIFORNIA.

During the eleven years from 1889 to 1899, inclusive, from data gathered by the Department of Highways, compiled from records in the various counties in the State, it is shown that the expenditures for road purposes were in excess of $18,500,000. This vast sum does not include expenditures upon the streets of municipalities and villages, nor does it include all of the payments for bridges, large parts of which have been paid for out of the County General Fund. Were the expenditures for all of these included in the road-tax, they would largely exceed the sum of $20,000,000; so that it may be assumed that the expenditures for road purposes in the State of California approximate $2,000,000 per annum.

To one conversant with the highways of this State it would seem unnecessary to intimate that, save in a few localities where roads are naturally good, the condition of California roads is most deplorable. The systemless and makeshift manner of locating, constructing, and maintaining roads becomes evident to any one who travels them for any considerable period. Yet, the conditions prevailing in California are exceptionally favorable to road construction and maintenance. The geological, topographic, and climatic conditions cannot be surpassed in any other State. Severe freezing, which is the bane of road construction in other sections, is unknown (except in the highest altitudes), thus removing one of the great difficulties which generally confront road-builders. In almost every locality of the State, suitable material for macadamizing or otherwise surfacing roads is abundant. The valleys of the State generally permit of easy location for highways, and in the mountainous section of the State numerous passes facilitate the good location of roads. The main drawback in some sections is the lack of water for road-sprinkling, which, generally considered, is the most economic method of road maintenance in this State; but even this is overcome, especially in the southern section of the State, where the use of oil for this purpose is becoming general.

Thus, it will be seen that natural conditions generally favor highway construction in California. In addition to this, it is seen that large sums of money have been raised for and, presumably, expended upon the highways, while it is also seen that the mileage of roads in good condition within the State is infinitely small.

To the inquiring mind, the question at once suggests itself: Why does this state of affairs prevail? There can be but one answer: All work upon the highways within California has been conducted with but little method or system. Vast sums of money have been injudiciously and extravagantly expended. The methods, like the roads themselves, are full of ruts, from which it is difficult to turn out. There can be but one remedy: radical changes in these methods; and, until such radical changes have been inaugurated, the State of California can hope for no progress along this much-needed line of improvement.

The citizens of California, and not alone of California, but of the entire United States, have begun to appreciate that, while the State and Nation have made vast strides in civilization and industrial wealth, yet, with all of this progress, there has been absolute retrogression in highway construction.

HISTORY OF ROAD-BUILDING IN THE UNITED STATES.

In connection with the above, it would be interesting to note something of the history of road-building in the United States. In but few particulars will the same history of other great civilized nations resemble that of our country. Had the energy of the Roman Empire, when at its zenith of power, or the industry of the Incas, before the conquest of Peru, been transferred to the United States, this country would have been linked together to-day with a system of magnificently constructed highways. Unfortunately, when America was settled by the English, the settlers brought with them from the mother country the imperfect methods which had been inherited by them from the Dark Ages. The Britons, having but few wheeled vehicles, had neglected the highways constructed by the Romans, these roads ultimately falling into decay. Britain had for centuries been provided only with bridle-paths, which, except in dry weather, were almost impassable. The idea of a central control, which is the only method by which extensive work has ever been successfully accomplished, had died out, and Macadam and Telford had not revived highway construction at the time of America's early settlement.

To quote in part from a report of the Office of Road Inquiry, United States Department of Agriculture:

The first settlements in the United States were located along the seashore and upon the banks of navigable streams. Narrow Indian trails led from the coast settlements to the interior, and were the only lines of communication up to the seventeenth century. Indeed, for a century after the settlement at Plymouth Rock, there were but few roads in this country passable by wheeled vehicles. The little traffic carried on between settlements was maintained by boats and pack-trains. A systematic attempt at road-building was then impossible, owing to the crude state of society and the sparse population. Soon, an eagerness to penetrate the wilderness seized upon the pioneer. Acting upon it, he blazed his way through the forests, built temporary bridges, and, with the steady increase in wealth and population, the pack-trail was widened into a crude wagon-road, but without any attempt at its improvement. A century elapsed before anything like improved highways were thought of; in fact, it was not until the beginning of the present century that any real improvement was perceptible.

The first great American road of which history tells us was begun in 1711, and ran from New York to Philadelphia, being known as the "Old York Road." The opening of roads was an important affair at that period, and, doubtless, was more of an undertaking than is the construction of a railroad at the present day. By studying the history of the Old York Road, we see the potency of the adage that "the history of roads is the history of civilization." The Indian trail, the blazed trees, followed by the bridle-path, then the rough road for carts, subsequently graded and paved, are all stepping-stones to a higher degree of civilization and wealth.

In early Colonial days, roads were first built and maintained by the use of volunteer or free labor, and at the town meeting, held on the village green, the opening and maintenance of roads were the most interesting subjects of discussion. The citizens would here offer their services free of charge to the community, for building and maintaining roads running through or by their lands. These offers, however, soon became so limited that the towns were forced to pass ordinances compelling all able-bodied men to work the road a specified number of days, or, in lieu of said labor, to pay a money tax to the pathmaster or road overseer.

It is easy to trace progress in all matters which were discussed on the village green, save one, that being the forced-labor system of working roads, which still exists in many of the States, and is yet found in some of the counties of California, where it is largely a farce—no greater one to-day, however, than it was in New England a century ago, as witness a letter under date of November 30, 1785, written by George Washington to Patrick Henry, then Governor of Virginia:

> Do you not think, my dear sir, that the credit, the saving, and the convenience of this country all require that our great roads leading from one place to another should be straightened, shortened, and established by law, and the power in the county courts to alter them be withdrawn? To me these things seem indispensably necessary, and it is my opinion that they will take place in time. The longer, therefore, that they are delayed, the more people will be injured by the alterations when they happen. It is equally clear to me that, putting the lowest valuation upon the labor of the people who work upon the roads under the existing law and the customs of the present day, the repairs of them by way of contract to be paid by an assessment in a certain district, until the period shall arrive when turnpikes may with propriety be established, would be infinitely less burthensome to the community than the present mode. In this case, the director would meet no favor. Every man in the district would give information of neglects, whereas *negligence under the present system is winked at by the only people who know the particulars or can inform against the overseers.* For strangers had rather encounter the inconvenience of bad roads than the trouble of an information, and go away prejudiced against the county for the polity of it.

This system of working out the tax and of lax highway methods was not too small a matter for the greatest of Americans to give thought to.

The maintaining of turnpike roads by chartered companies was inaugurated just prior to the outbreak of the Revolutionary War. State and National charters were given to these companies, which at first yielded large profits to their owners, and this system has been in vogue in Kentucky and some other States to a large extent to within recent years.

The Wilderness Turnpike was the name of one of the earliest, and ran from the Shenandoah Valley in Virginia, across the Allegheny Mountains at Cumberland Gap, thence to central Kentucky. This route, first opened for pack-trains, was afterwards so improved that it became the main road for wagon-trains from Virginia to the valley of the Ohio, a large commerce being carried on from Virginia to the west over it. During the first decade of this century, it was known as the best highway south of the Potomac River; but, with the construction of railroads, its revenues became so limited that it was neglected and allowed to go to decay.

That these roads were of great importance may be illustrated in the case of the Philadelphia-Lancaster Pike, chartered in 1792 to build a road from Philadelphia to Lancaster, a distance of 60 miles. The charter having been secured, in ten days' time there were 2,275 subscribers for stock. As this was more than the law allowed, the names were all placed in a lottery wheel, and 600 drawn. With these, subscriptions were begun. The builders of that day, however, seemed to have known no more of road construction than do those of the present. The land having been condemned, the trees were felled and the roadbed prepared; the largest stones that could be found were dumped upon it for a foundation, and upon this colossal base earth and gravel were spread. Then the work was declared completed. But, when the washing rains came, deep holes appeared on every hand. Sharp stones extended above the surface, and the horses' limbs were badly cut and sometimes broken, as they sank between the bowlders. The gigantic error of the road-builder was then made plain. (This method, however, is still in vogue in some sections of California.) Indignation meetings were held, the Turnpike Company condemned, and the Legislature blamed for issuing the charter. Had it not been for an Englishman, who offered to rebuild the road on the Macadam plan, improved road construction would have received a severe blow. When the road was rebuilt by him, it was declared by all persons traveling it to be the best piece of highway in the United States.

The success of the Lancaster Pike encouraged road-building everywhere, and before the first decade of the new century had elapsed, many of the well-settled States were voting money, setting aside revenues derived from the sale of public lands, and establishing lotteries to build turnpikes. The prospect of increased land values by the construction of these improved roads, and of receiving large dividends from money invested in them, induced many to risk their all upon these schemes. Speculation ran riot. Turnpike-building was the rage; and in a few years a sum of money was invested almost as large as the public debt at the close of the Revolution. By the year 1811, over 317 pikes had been chartered and constructed in New York and the New England States; their length being slightly in excess of 4,500 miles, many miles being surfaced with thick wide planks, which, for a few years, were successful, but on their decay this method of surfacing was abandoned. The toll system also proved unsuccessful, and many of the companies lost money. Some were bought out by the States and counties, while others surrendered their charters, and gradually again the forced-labor system came into vogue. The States exercised no supervision whatever over the roads within their confines, and skilled road engineers and builders soon became a thing of the past.

Early in the present century, when the movement started in England by Telford and Macadam in favor of broken stone roads, the importance of improved roads for military, postal, and commercial purposes began to be widely appreciated. Road reform assumed such proportions that it began to be one of the leading questions of national politics, being supported by such statesmen as Washington, Jefferson, Calhoun, and Clay. It was admittedly, next to the tariff, the most important subject under consideration in Congress—Congress being split into two parties on the subject. Those who believed in a liberal construction of the Constitution favored the construction of roads by the General Government, while the strict constructionists denied the power of the Government to spend money for such internal improvements.

During Jefferson's second term, Ohio was admitted, the act of admission containing a provision to the effect that five per cent of the net proceeds derived from the sale of public lands within the boundaries of the State should be expended in the construction of public roads, leading from the navigable waters emptying into the Atlantic Ocean to and through the State of Ohio. In 1806, the sum derived from this source amounted to over $600,000, and $30,000 was at once made available for the construction of the famous Cumberland Road. From its initial point, at Cumberland, Md., it was to extend through southwestern Pennsylvania, across the Allegheny Mountains, to the Ohio at Wheeling, W. Va., and thence to St. Louis, Mo. Constructed under the principles advanced by Telford and Macadam, it was so well built that it yet remains a good road, though it has long since passed out of the hands of the nation, and has not been repaired for years. The road was described by a writer, in 1879, as follows:

> It was excellently macadamized. The rivers and creeks were spanned by stone bridges, the distances indexed by iron mile-posts, and the toll-houses supplied with strong iron gates. Its projector and chief supporter was Henry Clay, whose services in its behalf are commemorated by a monument near Wheeling. There were often twenty gaily painted four-horse coaches traveling the road each way daily. The cattle and sheep were never out of sight. The canvas-covered wagons were drawn by from six to twelve horses. Within a mile of the road the country was a wilderness, but on the highway the traffic was as dense as in the main street of a town. Ten miles an hour is said to have been the usual speed for the coaches, but between Hagerstown and Frederick they were claimed to have made 26 miles in two hours. These coaches finally ceased running in 1853. There were also through freight wagons from Baltimore to Wheeling which carried ten tons; they were drawn by ten horses, and their rear wheels were ten feet high.

From 1810 to 1816, appropriations amounting to $680,000 were made by Congress for continuing the work on this road.

In 1817, John C. Calhoun, Henry Clay, and others favored the creation of a new fund for internal improvements. A bill was introduced in the House by Mr. Calhoun to set aside for roads and canals the bonus and dividends received by the United States from its newly chartered national banks. In supporting this measure, Mr. Calhoun, although a staunch believer in the doctrine of State rights, delivered a speech before the House, in which he thus expressed himself:

> Let it not be said that internal improvements may be wholly left to the enterprise of the States and of individuals. I know that much may be justly expected to be done by them; but in a country so new and so extensive as ours there is room enough for all. the General and State governments and individuals, to exert their resources. Many of the improvements contemplated are on too great a scale for the resources of the States or of individuals, and many of such a nature that the rival jealousy of the State, if left alone, might prevent. They require the resources and the general superintendence of the Government to effect and complete them.
>
> But there are higher and more powerful considerations why Congress should take charge of this subject. If we were only to consider the pecuniary advantages of a good system of roads and canals, it might indeed admit of some doubt whether they ought not to be left wholly to individual exertions; but when we come to consider how intimately the strength and political prosperity of the Republic are connected with this subject, we find the most urgent reasons why we should apply our resources to them, Good roads and canals, judiciously laid out, are the proper remedy. Let us, then, bind the Republic together with a perfect system of roads and canals.
>
> The fund proposed to be set apart in this bill is about $650,000 a year, which is doubtless too small to effect such great objects of itself, but it will be a good beginning. Every portion of the community—the farmer, the mechanic, and the merchant—will feel its good effects; and, what is of greatest importance, the strength of the community will be greatly augmented and its political prosperity rendered more secure.

Henry Clay also spoke in favor of the proposed Act with reference to its constitutional merits. The bill was unfortunately amended, however, and President Monroe vetoed it. An attempt was made to pass it over the President's head, but failed of the necessary two-thirds majority. Upon the defeat of the bill, Congress returned to its former method of providing funds derived from the sale of public lands.

In 1811, five per cent of the net proceeds of the sale of public lands in Louisiana was given to that State for the building of roads; in 1816, the same percentage was given to Indiana; in 1817, a like sum to Mississippi; in 1818, two per cent was given to Illinois; in 1819, five per cent to Alabama; in 1820, five per cent to Missouri; in 1845, five per cent to Iowa; the sum total derived in this way exceeding $7,000,000.

After the construction of the Cumberland Road was begun, twelve other great national highways were laid out, and appropriations given them amounting to a total of $1,600,000. Supplementing these appropriations, grants of land were made from time to time by the States to aid in the work, and the labor of United States troops was occasionally employed. The financial crisis of 1837 put a quietus on all projects requiring large Government expenditures.

In 1854, another period of activity began, and lasted until the outbreak of the Civil War, during which time appropriations aggregating $1,600,000 were again made.

From that time to this, only a few military roads have been built, and, of late years, nothing has been done in the way of National aid, save the building of roads in the District of Columbia and in National cemeteries and reservations. It would seem, however, at the present time that Congress would again become actively awake to the importance of the improvement. Some road-reformers think, as thought many of the forefathers who founded the Republic, that the General Government should aid in the building of the principal roads. This idea has, however, met with little encouragement.

Out of the agitation, however, has grown the Office of Public Road Inquiry, attached to the Department of Agriculture. This bureau was created in 1893, to collect and disseminate information on the road subject, to conduct investigations, inquiries, and experiments regarding road materials and road construction, and to encourage, by object-lessons and otherwise, the building of better roads. Numerous bulletins and circulars have been issued by it, which have proved of much use to practical road-builders, and a number of experimental roads have been constructed in various sections of the United States. There is now before the National Government a project for the construction of great National highways, one of them commencing in Maine and running to San Diego, California. This is in the hands of a Special National Highway Commission, embodying among its members such well-known men as Lieutenant-General Nelson A. Miles and Brigadier-General Roy Stone; while, within California, the National Government has conducted an examination for roads within the Yosemite National Park, and bills are now pending in Congress for the acquirement of certain existing toll-roads, and for the construction of new roads within the Park, amounting in the aggregate to $400,000.

HIGHWAY LEGISLATION IN OTHER STATES.

Many of the States of the Union have passed new and progressive road laws, the general trend of this legislation being as follows:

(1) The establishment of State Highway Commissions;

(2) The construction of State roads, and extension of State aid to road-building;

(3) Construction by townships, counties, and districts, with power to issue bonds;

(4) More liberal tax levies;

(5) Local assessments, according to benefits;

(6) The substitution of a money tax instead of labor;

(7) Wide-tire laws;

(8) Provisions for convict labor.

The following is a brief résumé of

THE ADMINISTRATION OF ROADS IN OTHER STATES.*

ALABAMA.

The Court of County Commissioners selects appraisers for each precinct, these in turn appointing overseers, who have general charge of road-repairing in their particular sections. Every able-bodied man is liable to ten days' labor on roads, special acts in some of the counties allowing this to be commuted in money. Some counties have a special road-tax out of the general levy, while others issue bonds, to be redeemed out of the general tax receipts. Every Legislature passes special acts for the various counties, these acts varying much in their provisions.

While a considerable mileage of good macadam roads has been constructed, these are confined to the counties issuing bonds, or requiring the road-taxes to be paid in money.

ARKANSAS.

Road overseers are appointed by the County Judge. Every man is required to work from five to ten days a year on the roads, and but little improvement has resulted. The roads are very poor.

COLORADO.

The County Commissioners divide the counties into road districts, appointing a road overseer for each, who sees to general repairs, etc., of the road. The Commissioners also levy a property road-tax, one half of which must be spent in the district in which it is levied, the balance at the discretion of the Commissioners. Every able-bodied man between the ages of 21 and 45 years is subject to a road-tax of $2, which can be worked out by two days' labor on the roads, or one day's work with team, or is liable to a penalty of $5.

CONNECTICUT.

This State has made rapid progress in the good roads movement, and, since the State-aid system was adopted five years ago, some 500 miles of excellent Telford, macadam, and gravel roads have been constructed, while the improvement of several hundred miles is in progress or has been projected.

Primarily, the roads are under the supervision of the Selectmen of the town, who employ laborers and supervise the work of road improvement, the necessary money being derived from the general tax fund. The old practice of working out taxes is fast disappearing.

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*Information on this subject has been obtained from correspondence with various officials of other States, from various pamphlets and bulletins of Office of Road Inquiry, Department of Agriculture, from Report on Highways of Maryland, Maryland Geological Survey, 1899, and from other sources.

In 1895 a law was passed whereby three Highway Commissioners were appointed by the Governor of the State, with an appropriation of $75,000 annually, to be spent on the roads of the State. Under the Act every town voting to improve its roads had a survey made, specifications drawn up, and submitted to the State Highway Commission. If approved, a contract was let, the work being carried on under the superintendence of the Selectmen, and the expenses met—one third by the town, one third by the county, and one third by the State. In 1897 the number of Highway Commissioners was reduced to one, the appropriation being increased to $100,000 annually, and the expense of road construction was divided equally between the town and the State.

The large mileage of improved roads (noted above) under this system has proved the popularity and efficacy of the present law, and the people of the various towns, encouraged by the State aid, and recognizing the great advantages and conveniences of good roads, have readily voted sums for their improvement.

DELAWARE.

In this State two road systems exist. In New Castle County, Road Commissioners are elected, they having general charge of the roads and bridges, with power to appoint overseers; they also levy the tax, which may be worked out. In Kent and Sussex counties powers similar to those of the Road Commissioners lie with the Levy Court, which appoints supervisors, fixes the amount of road-tax, etc.

FLORIDA.

Roads are in charge of the county officials, the tax being paid largely in money, some of it being worked out. Natural conditions are such as to make most of the roads fairly good, and considerable interest is manifested in their further improvement.

GEORGIA.

In this State road improvement is making a steady march. Roads are being substantially improved, many miles being macadamized or graveled.

The country is divided into road districts, each having three Commissioners, with power to further divide the districts into sections and appoint overseers.

Every able-bodied man is subject to fifteen days' work annually on the roads. Counties are permitted to levy a road fund, to organize road forces, or to contract for repairs.

Much of the work of macadamizing and graveling has been performed by convict labor, which has proved successful in this State.

There are two classes of roads: the first class must be 30 feet wide, and the second class not less than 20 feet in width.

IDAHO.

The roads are in charge of County Commissioners, who appoint Road Supervisors to see to repairs.

The road-tax, consisting of property- and poll-tax, is levied in the county, and spent in the district where it is raised. It may be worked out. Some help is received from the State in regions where the expense of road- or bridge-building is too great to be borne by the locality.

ILLINOIS.

The township and county systems of road government are both in general use. There are three Commissioners in the township or county, who have complete charge of the roads and bridges in their respective township or county. They may contract, employ laborers, or appoint a general superintendent and overseers, and report semi-annually on road matters and finances to the Board of Town Auditors. They levy a road-tax, consisting of property- and poll-tax, the latter being commutable by labor. Upon petition, roads may be altered, opened, or vacated by the Commissioners of Highways, provisions being made for arbitration before a jury, or appeal to three County Supervisors, if necessary.

The County Board may render financial assistance to a township in case of expenditures too great to be borne by the township, such as the building of expensive bridges, etc.

The townships or counties may vote a special tax for road improvement, and some good results have been accomplished in the way of the macadamizing and graveling of highways. The matters of wide-tires and sign-boards have also received some attention.

INDIANA.

The counties are divided into townships, each having a Trustee, and the townships are subdivided into road districts, over each of which a Supervisor is elected, who is under the direction of the Township Trustees. The latter, with the concurrence of the County Commissioners, fixes the road-tax, part of which must be worked out or a fine paid. An additional levy may be made if the ordinary levy does not produce sufficient funds.

Upon petition for a new road, the Commissioners appoint viewers, who decide on the location and amount of damages. The County Commissioners report their decision to the Trustees of the township through which the road passes, and the latter order the Supervisors to do the work. County roads shall not be less than 30 feet wide, and township roads 25 feet wide.

The State of Indiana has a large mileage of graded, graveled, and piked highways, most of which have been acquired by construction and purchase by the County Commissioners, on petition or vote, and paid for by special tax or county bond.

IOWA.

Each county is divided into townships, and the Township Trustees have special charge of the roads in their respective townships. The County Boards of Supervisors have general supervision over the roads of the counties, and may also levy a road fund, to be expended under their direction on roads in the county, by contract or otherwise.

The Trustees may subdivide their districts, levy road-tax, and decide as to the amount to be paid in cash and amount in labor; they may also appoint a Township Superintendent of Roads, and, in case of subdivision of the township into districts, part of the road fund is laid aside for general purposes, such as the purchase of tools, road machinery, sign-posts, etc., and the balance expended in the district where it is raised.

The opening, altering, or vacating of a road is accomplished by petition to the Board of County Supervisors. The County Auditor appoints a commissioner to report on the matter, and, if there be no objection, work is proceeded with. In case of a claim for damages, the Auditor appoints three appraisers, and the County Supervisors decide from their report as to the amount of damages, and whether or not the work shall proceed. Appeal for damages may be had to the County District Court.

All able-bodied men are subject to two days' work on the roads, or to a fine of $3 for each day they fail to work.

The general width of roads is 66 feet, but the Supervisors may limit this to 40 feet.

The County Auditor is required to keep a plat of all public roads in each township of his county, on a scale of not less than 4 inches to the mile.

KANSAS.

Very little attempt has been made toward the betterment of roads in this State. The roads are in charge of Township Overseers, who are elected by the popular vote.

Road-tax, consisting of property- and poll-tax, is levied by the county officials, and may be partly worked out.

KENTUCKY.

Kentucky was famous for her fine roads a generation ago, and few States have been more liberal in promoting the building of better highways.

Over 1,000 miles of excellent stone roads have been built in Kentucky, as toll, county, or State roads. The old toll-roads are being bought up and made free by the various counties as fast as possible, prices ranging from $75 to $250 per mile. Some of these, however, are given up to the counties at no cost whatever. Shelby County has recently bought up 117 miles of turnpike at a total cost of about $15,000. A large percentage of the roads, however, is still worked by forced labor, every man between 18 and 50 years of age, not a citizen of an incorporated city or town, being compelled to work on the road six days a year, or pay a fine of $2.50 per day.

The Fiscal Court of each county has general charge of roads and bridges, and levies the annual road- and poll-tax, the County Judge dividing the county into precincts and appointing an overseer for each. In some of the counties, the court appoints a supervisor (as a rule, an engineer) to take general charge of roads and bridges, and he may make contracts for their repair.

Some counties have borrowed money on bonds.

All male persons in county jails or workhouses, under sentence of hard labor, shall be available for public work on the roads.

A movement is now on foot to secure more uniform taxation by passing a State-aid law, and the agitation has already led to a general crusade which foreshadows thorough reformation.

LOUISIANA.

There has been some slight road agitation in this State, but with little result. The Parish Police Jury appoints road overseers, road expenses being met from the general parish tax-fund, some of the parishes keeping roads in repair by contract.

Every able-bodied citizen is compelled to labor twelve days annually on the roads.

MAINE.

Road Commissioners, who are elected annually by the town, have control of the roads in their respective townships, except in the thinly populated districts, or "plantations," where the County Commissioners have charge. In some of the smaller towns, a special road-tax is levied, but, as a rule, the road expenses are met from the general tax-fund of the town.

The State lends some little aid by an occasional appropriation for a special road or bridge, this being constructed under supervision of a special agent appointed by the land-agent.

MARYLAND.

The Maryland Highway Division of the State Geological Survey, since its creation by the Legislature in 1898, has made a searching and most careful inquiry into the road question in that State, embodying the result of such investigation in a most exhaustive and interesting report, strongly recommending the creation of a State Highway Commission.

As a rule, the roads of the various counties are under the immediate charge of Supervisors, who employ laborers, make contracts, etc., for construction and maintenance of roads.

From the report of the Geological Survey, it appears that good road material is abundant in most sections of the State.

There are about 500 miles of toll-road in the State, including among their number some of the oldest pikes in the United States. The total mileage of roads is given as 14,483, of which there are 890 miles of stone roads, 225 miles of graveled roads, 250 miles of shell roads, and 13,118 miles of dirt roads; or, classifying the roads as main thoroughfares and byroads, there are found to be 2,021 miles of main roads, or about 14 per cent of the total mileage.

In view of the excellent recommendations in the report and the able manner in which the subject has been handled by the Geological Survey, road-building in Maryland will undoubtedly receive a great impetus, and reform in the way of more uniform road laws, with a central authority, will likely result.

MASSACHUSETTS.

This State has been one of the leaders in the agitation for road improvement. A permanent Highway Commission, consisting of three Commissioners, was created by the Legislature of 1893. Most liberal appropriations have been granted the Commission for the building and maintaining of State roads—in 1894, $300,000; in 1895, $400,000; running as high as $800,000 in 1897; $400,000 in 1898, and $500,000 in 1899.

The Selectmen of a town, the Mayor and Aldermen of a city, or the County Commissioners may petition the Highway Commission to have a road improved and maintained by the State, and, if the plans are satisfactory, the Commission undertakes the work. Not more than 10 miles of road can be built by the Commission in any one county in one year. The whole expense is primarily borne by the Commission, but the county in which the improvements are made must repay to the State one fourth of the amount expended within six years after the construction of a State road.

In order to meet the high expense of the Commission, a highway loan has been made, amounting to $2,700,000, and 3½ per cent thirty-year bonds issued to raise the money.

About 300 miles of excellent road have been built by the Commission, a great part of this mileage being over the worst and most difficult parts of the country to traverse; and such an object-lesson of convenience and economy have these improved highways proven to the people that petitions are being continually received by the State Highway Commission for the improvement of roads, to an amount far in excess even of the liberal appropriations by the State. The average expenditure has been about $9,000 per mile, but, as noted above, attention has been first given to the worst parts of the highway system.

To the State of Massachusetts and her Highway Commission are due the thanks and praise of all interested in road reform, for solving, as they seem to have done, the great question of the proper and lasting (and therefore, the most economical) method of road construction and maintenance.

MICHIGAN.

The district and township system was formerly entirely in use in this State; but in 1893 a law was passed allowing counties, on vote of the people, to revert to the county government method. Under this system of administration all the county roads are under the direction of the County Road Commissioners, and the office of Township Commissioner ceases to exist.

By an Act of the Legislature of 1895, in any county where the Supervisors refuse to submit the question of adopting the county road system, or where the question has failed to carry, the question of township roads may be submitted.

Under the township system the amount of road-tax in each township is fixed annually by the vote of the people, who also decide as to what proportion shall be paid in cash and what proportion shall be worked out. There is also a poll-tax.

When construction or repair work is necessary to be done on a road, if the amount exceeds $50 it must be let by contract; if in excess of $100, the Road Commissioners must have the concurrence of the Township Board, the latter exercising authority over the expenditure of sums up to $1,000, and work, the cost of which will exceed this amount, can only be undertaken on vote of the people. The Road Commissioners have the right to alter, vacate, or open roads, power of decision on appeal vesting in the Township Board.

MINNESOTA.

The State of Minnesota is rapidly falling into line with the good roads movement, and, undoubtedly, ere long will establish a State Commission.

In 1897 an amendment to the Constitution, permitting the State to aid in highway construction, was adopted by a vote of the people, and in 1899 a bill was introduced to create a State Highway Commission for the purpose of investigating the road problem in the State, and to establish a highway fund whereby the State might pay one third of the expense of construction and maintenance of the most important highways in the State. Owing, however, to the fact that the constitutional amendment above mentioned was not clearly understood, the bill failed of passage. But the movement is by no means dead, and, when a proper understanding is reached, a State law along the lines mentioned will be enacted.

At present the roads are generally under the supervision of overseers, who are elected by the township voters. A property- and poll-tax are collected, which may be worked out. Under the statutes of 1895, upon a petition being filed with the Auditor, the Board of Commissioners may construct the road. Viewers and engineers shall be appointed to assess damages, estimate costs, etc. Bonds may be issued as the work progresses, and a tax levied to meet the interest on such bonds, and to make a sinking fund. The election of overseers and the collection of poll-tax may be abolished on vote of the people in any township, and the roads put under the direct supervision of the Township Supervisors.

MISSISSIPPI.

Little interest is manifested in the improvement of roads. The County Supervisors appoint overseers, who have charge of road repairs. Every able-bodied male citizen is subject to ten days' work on the roads, but this law is not rigidly enforced.

MISSOURI.

The counties are divided into districts, over each of which the County Court appoints three Commissioners, who have entire control of all road and bridge work, with power to employ laborers or to make contracts for the necessary work.

There is a property- and poll-tax, the latter commutable by labor, both expendable in the district where collected. In addition to these taxes, there is collected a special tax of 15 cents on the $100 assessed valuation of real and personal property, to be spent on the county roads.

The use of a portion of the liquor license for road work has become general in counties throughout the State.

Over $3,000,000 is expended annually on roads.

MONTANA.

The counties are divided by the County Commissioners into road districts, and a supervisor is annually elected for each district, to serve one year. The supervisors, under the Commissioners, have charge of the roads, employing labor therefor. A property-tax of from one to two mills on the dollar, and a poll-tax of $3 on voters, are levied by the Commissioners, which taxes may be worked out.

NEBRASKA.

Natural conditions tend toward the easy construction and maintenance of roads.

A labor and money tax are levied, part of the latter being commutable in work.

Townships and counties are divided into road districts, with overseers in charge of the same.

NEVADA.

The roads are controlled by the County Commissioners, who, upon the application of a majority of the voters of any county, may open, alter, locate, or vacate any public road.

NEW HAMPSHIRE.

Under an act of the Legislature of 1899, the following law became effective in those towns which, by vote, adopted it:

Each town is divided into as many road districts as the Selectmen of the town may think expedient, they appointing a Surveyor of Highways to take charge of the roads in each district. As a rule, the taxes are expended in the district in which they are collected, but, if there be a surplus in any district, the Selectmen have the right to transfer such surplus to the road fund of any other district. About one fourth of the counties have voted to adopt this law.

In general, each town constitutes a road district, the town electing from one to three Highway Agents to supervise all work on roads and bridges. At the annual election of the town, the road-taxes are fixed as a certain proportion of the polls and of the general taxes levied.

Some aid has been received from the State in the construction of roads, and the State Board of Agriculture now has in hand the matter of disseminating information as to road construction and maintenance.

NEW JERSEY.*

New Jersey was the first State to take any radical step toward the improvement of her public highways. Her State-aid law was passed in 1891. It provides that on petition of the owners of two thirds of the lands bordering any public road, not less than a mile in length, asking that the road be improved, and agreeing to pay 10 per cent of the cost, the county officials shall improve the road, one third of the expenses to be borne by the State, if the road is brought to the standard fixed by the State Commissioner of Public Roads, and the balance ($66\frac{2}{3}$ per cent) by the county. The State's expenditures for such improvements in any one year are limited to $150,000, while the county is limited to one fourth of one per cent of its assessed valuation. At this rate, the law makes possible the expenditure of $450,000 a year, and at $3,000 per mile this builds 150 miles of road. Ten miles of road were built in 1892, 25 miles in 1893, 60 miles in 1894, and since 1895 the application for new roads has been far in excess of the limit prescribed by law.

Under this law, about 450 miles of improved road have already been built in New Jersey, the State's portion of the expense being about

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*Yearbook, U. S. Dept. Agriculture, 1899.

$715,800. The counties and towns have built out of their own treasuries 450 more miles, which brings the total mileage of improved roads in the State up to 900. These roads cost at first about $6,000 per mile, but on account of the reduction in the price of materials and the increase of labor-saving machinery the cost has been reduced to about one half of this amount. The farmers, who at first strongly opposed the law, are now equally enthusiastic for it, and more roads are being petitioned for than can possibly be built in many years out of the limited State appropriation. The system seems to be popular with all classes.

NEW YORK.

The Legislature of 1898 passed a bill providing for the improvement of roads by State aid. The County Supervisors may, of their own motion or on petition of the property-holders, request the State Engineer to improve certain county roads. Surveys are made, and maps and specifications prepared, and, on approval by the State Engineer, the County Engineer (if there be one) assumes charge of the work. If there be no County Engineer, a competent engineer is appointed by the State Engineer to supervise the work. The State stands 50 per cent of the cost of such improvement, the county's share is 35 per cent, and the town's share the remainder.

The law seems to give satisfaction; a number of miles of excellent road have been constructed, and work is in progress under its provisions.

Under an Act of 1895, bonds may be issued to defray the expenses of purchasing road material in certain towns adjoining cities of 35,000 inhabitants.

NORTH CAROLINA.

In general, the counties are divided into townships, and these are subdivided into road districts. In some counties, a Road Superintendent is elected by the people or by the County Commissioners, and he in turn appoints supervisors of the various townships. Where no superintendent is elected, the supervisors are elected by County Commissioners.

Many of the counties levy a property- and poll-tax, and some have, by virtue of State legislation, issued bonds for road improvement.

According to legislation in 1899, modeled after the former "Mecklenburg law" of 1879, and applying to a number of counties, the County Superintendent of Roads, or Township Supervisors, are elected by the County Commissioners.

In some counties, a regular road-tax is levied, and each able-bodied man must labor four days on the road or pay $2 poll-tax, but this system of forced labor is dying out.

Laws are in force, providing for the use of convict labor in improving highways, and North Carolina has made greater progress and built more miles of road under this system than any other State.

NORTH DAKOTA.

Under the law of 1895, the several town boards have general supervision over the roads, highways, and bridges throughout their several townships.

The amount of road-tax, not to exceed 80 cents on $100 of assessed value of real and personal property, is fixed by vote at the regular annual town meeting, and, on petition, the question of maintenance of roads by contract may be submitted to the voters of the township.

In addition to this, counties of more than 3,000 inhabitants may levy a county road-fund, to be expended under the direction of the County Commissioners.

OHIO.

The roads are classified as: (1) State roads, connecting the counties; (2) County roads; and (3) Township roads. The County Commissioners have charge of the State and County roads, and fix the amount of tax for the same, while the Township Trustees exercise similar authority over the township roads.

Laws are in effect, providing for the proper marking of the State and County roads by monuments, for proper engineering supervision, etc.

OREGON.

The County Court has general supervision over all roads, and may open, alter, or vacate them on petition, after the report of three viewers, who are appointed by the court.

The road-tax is levied in labor, consisting of a property-tax of one day's labor for each $1,000 of assessed valuation, and poll-tax of two days' work annually. These may be commuted in money by order of the County Court.

The general tax-fund may be drawn on in some instances of unusual expense, such as bridge construction, etc.

A fund for the improvement of roads and bridges has been created out of a portion of the receipts from the sale of the public lands of the State and from the tax collected by the National Government in 1861, which has since been repaid to the State. This will be divided proportionately among the counties.

The employment of convicts on county roads, under the Supervisors, is authorized, and the placing of guide-posts and milestones is provided for by law.

In 1900, a wide-tire law became effective, providing for a rebate of $1 per wheel on all wagons having tires over three inches wide, and of $2 per wagon having tires over four inches wide.

The roads in the State are generally good. In one county alone (Allegheny) 25 miles of road were opened, improved, and dedicated to the public in 1898, and in 1899 this was increased to 50 miles. These roads have been macadamized and drained at an average cost of about $6,000 per mile. The width of the main roads is about 33 feet, and they traverse populous rural districts. About 85 miles of road in this county are either contracted for or are now undergoing improvement.

RHODE ISLAND.

The roads are under the supervision of the town Highway Commissioners, who appoint supervisors. At the annual town meeting, a certain sum for the construction and maintenance of roads is appropriated from the general tax-fund.

At the suggestion of the State Commissioner of Highways, the Legislature recently passed a law, enabling him to build a half-mile sample of good macadamized highway in each town applying for the same, three fourths of the cost being met by the State and one fourth by the town. Although this law has been repealed, these permanent object-lessons have been of great benefit to the towns, and are conducive to more liberal appropriations for roads, as well as to more thorough construction. Out of 2,240 miles of highway in Rhode Island, about 500 miles have been improved by the use of gravel and stone.

A wide-tire law has been passed, to go into effect in the year 1902.

SOUTH CAROLINA.

The Township Supervisors appoint road overseers, who supervise the work on the roads.

The people of Columbia, S. C., have recently expended $6,000 in the purchase of a fine plant of machinery for road-building, consisting of steam-rollers, rock-crusher, road-grading machines, etc. The rock-crusher is capable of turning out 60 tons of rock daily. Good results will be accomplished, as this is a step in the right direction, and the people of other sections will soon realize the necessity of good roads, constructed in an economical manner by the use of improved machinery.

Convict labor has been employed to some extent.

SOUTH DAKOTA.

In the level portions of the State the roads are generally good, but in the mountainous parts they are, as a rule, exceedingly bad, and but little effort seems to have been made toward their improvement.

The counties are generally divided into townships, the trustees of which have charge of the roads, Road Supervisors being elected under them. Where the township system does not exist, the County Commissioners have charge. The County Commissioners fix the road-tax, consisting of a property- and poll-tax, both commutable by labor, to be expended or worked out in the district where the tax is levied.

TENNESSEE.

A long step was taken in Tennessee by the adoption of a new road law, which went into effect January 1, 1900. This law abolished the office of Road District Overseer, and under it but one Road Commissioner for each county is elected biennially by the County Court, he to have complete charge and oversight of all road and bridge work in his county, the opening, closing, and altering of roads being accomplished on petition to the Commissioner, the Court fixing damages, etc. All work on the roads must be done by contract, proposals for the same being submitted at the beginning of each calendar year, and the contractors have the right to call on delinquent taxpayers for labor. A high standard of specifications has been established for the main highways.

Bradley County, Tenn., has now about 100 miles of gravel and stone roads, having issued bonds for their construction, and there is a general revival of road-building throughout the entire State.

Convict labor has been employed successfully.

A property-tax is levied by the County Court, and every able-bodied man is compelled to render a certain amount of work.

There is a large mileage of toll-roads throughout the State.

TEXAS.

The roads, as a rule, are in poor condition.

Supervisors, appointed by the County Court, have general charge of the roads.

A poll-tax is levied, requiring five days' work on the roads.

Convict labor has been employed to some extent.

UTAH.

The County Court exercises supervision over all road work, having power to open, alter, or close roads. The counties are divided into districts by the Court, which appoints a Supervisor biennially for each district.

A poll-tax is collected, which may be rendered in money or labor.

VERMONT.

Vermont has recently adopted the State system, and with much success, and an outlook for a bright future. The State Commissioner states that in the year 1899, 117 miles of road were built, being a mileage in excess of the total for the years 1892 to 1898, inclusive. At this rate, the Commissioner states, a fine State highway system will be established in a few years. The State pays one half of the cost of the improvement of main thoroughfares, while the other half is paid by the towns through which the road passes.

The duties of the State Commissioner are largely advisory, he conferring with the Road Commissioners of the town. The latter are elected annually for each town.

A road-tax is levied annually by the Selectmen of the town, and the money expended therein; the general tax-fund being drawn upon for special work, such as bridge construction and repairs, etc.

VIRGINIA.

The general conditions in Kentucky are applicable also to the State of Virginia, where the State-aid sentiment is also becoming very strong, and movement is now on foot for a more general system of road administration.

The county and townships systems are in vogue. A property road-tax and, in some counties, a poll-tax are levied by the township or county officers.

WASHINGTON.

The County Commissioners have primary jurisdiction, having power to appoint viewers for the purpose of opening new roads.

The counties are divided into districts, a Supervisor being elected annually for each, and the amount of road-tax fixed by vote, commutable by labor. A road-tax, payable in money, is also levied.

WEST VIRGINIA.

The County Court has general supervision over the roads. It appoints viewers to report upon the advisability of opening new roads, to assess damages, etc. It determines the amount of road-tax, part of which may be worked out, and appoints a surveyor for each district, who has direct charge over roads and bridges, with authority to employ labor.

Expensive work, such as building of bridges, etc., is done by contract, and is paid for out of the general tax-fund, by special levy, or by the issue of bonds.

There is a movement on foot looking toward the establishment of a better system of laws.

WISCONSIN.

Interest in road improvement in this State has recently been aroused by the Geological and Natural History Survey of the State, which has assumed the task of studying the road problem.

The Town Supervisors have complete control of the roads, levying a property- and poll-tax.

The wide-tire movement is encouraged by the exemption from taxation of wagons with tires three inches wide, or over.

WYOMING.

The County Commissioners have control of road affairs, and have power to open, alter, or close roads on report of viewers (or appraisers, if necessary) appointed by them, appeal being had to the Circuit Court; they also fix the annual road-tax levy.

A County Supervisor, elected biennially, has charge of the care of the roads, or, in case the county is divided into road districts, a Supervisor is elected for each.

ROAD ADMINISTRATION IN FOREIGN COUNTRIES.

In 1891, the Bureau of Statistics, Department of State of the United States, compiled and published reports from the Consuls of the United States on streets and highways in their several districts, the same being reissued, with supplementary reports, from the Bureau of Foreign Commerce, Department of State, in 1897, under the title of "Streets and Highways in Foreign Countries."

A short summary of the more important of these reports from the European consulates may not be amiss:

AUSTRIA.

The roads are classified as: (1) Imperial or State roads, which are subject to the administration and legislation of the State; and (2) Public roads, which are subject to provincial legislation.

In 1873, the total length of State roads was 15,003 kilometres, or about 9,300 miles. Only a small proportion of these roads is built with a heavy stone foundation, most of them being constructed of ballast or broken stone.

For the immediate carrying out of the work necessary for keeping in repair the State roads, road-keepers are employed by the Government; and road-masters and inspectors are employed in the larger districts, for conducting and superintending the work on the roads.

The width of tires is regulated by law.

In Austria, the average receipts of toll, collected upon the State roads, in the years 1860–1873, was 2,618,549 florins per annum, or over $900,000.

The Public roads are subdivided into: (1) Provincial roads, which have been so declared from their importance as such by resolution of the Diet; (2) District roads, which have been appointed as such by the respective district authorities; and (3) Community roads, embracing all other roads. Rules are prescribed for the uniform measurement of roads, as to width, depth of foundation, ditching, gradient, planting of trees, etc.

The building and maintenance of Provincial roads are incumbent upon the Provincial Committee, and the District roads are under the care of the District Road Board, which is supervised in its work by the Provincial Committee. Costs for the building and maintenance of Provincial roads are paid from the Provincial fund, while the District roads are maintained by the respective districts.

BELGIUM.

The thoroughfares in the kingdom of Belgium are: (1) Government roads, running from one part of the kingdom to another, controlled and managed by the State authorities; (2) Provincial roads, or chaussées, running between two points in a province, constructed and controlled by the provincial authorities; and (3) Communal roads, controlled by the communal authorities. They are paved in the center, a dirt road on each side, and are bordered with trees.

Each of the nine provinces has a Bureau of Roads and Bridges, whose chief gives his undivided attention to these matters.

The roads are most carefully engineered in the first place, heavy grades being carefully avoided. They are carefully paved and surfaced, and well rolled when repairs are made, most rigid specifications being adhered to in contract work.

Such a perfection has road-building attained in Belgium that the highways enter into successful competition with the railroads, and one is struck with astonishment at the enormous loads drawn by horses and dogs in this country.

FRANCE.

The French roads have compelled the respect and admiration of foreigners for a century, and they stand to-day as substantial monuments to the Napoleonic foresight and shrewdness, the modern road-system of the country having been inaugurated by the First Napoleon, and carried forward to its satisfactory and splendid conclusion by Napoleon the Third.

Of this country it is said that the far-reaching and splendidly maintained road-system has distinctly favored the success of the small landed proprietors, and in their prosperity, and the ensuing distribution of wealth, lies the key to the secret of the wonderful financial vitality and solid prosperity of the French nation. The road and bridge service of France is a strong and effective organization. Responsible men are employed in it, thoroughly trained, and their work is subjected to close inspection by the Government engineers.

The routes are divided into sections of from half a mile to three miles in length, each of which is confided to a man or a number of men, so that every foot of roadway is inspected daily, and kept in thorough repair. The highways of France are remarkable for their durability, evenness, and cleanliness. They are swept and watered every day, and kept in scrupulous order. Neither dirt, decay, nor rubbish is about, to suggest neglect or ill care.

The ways of communication are divided, generally, into three classes: (1) National or State roads, constructed and maintained by the State; (2) Department roads, in charge of the departments; and (3) Township roads, which, though constructed by the communes, receive in most cases support either from the State or from the departments for their maintenance. Each taxpayer is obliged to work three days a year for the maintenance of the country roads, or pay an amount of money equivalent to the compensation of a laborer for three days.

The National roads, radiating from Paris, are placed under the jurisdiction of the Department of Bridges and Roads (Ponts et Chaussées), which is attached to the Bureau of the Minister of Public Works, who is a member of the Government cabinet, and the roads are maintained out of the General State Fund. All road work is carried on under the supervision of skilled engineers, who, previous to the commencement of work, make a careful examination and survey of the route, and draw up rigid specifications for the contractors. Provisions are made by law for the condemnation of lands for road purposes.

The bridge system is very thorough, most of the bridges being built of stone, though, in recent years, the use of iron and steel structures has been introduced.

The average cost of building a road is about $6,600 per kilometre (1,093 yards), or somewhat over $10,000 per mile, being $4,000 per kilometre in the valleys, and $9,000 in the mountainous regions.

GERMANY.

The excellent roads of Germany are mainly a heritage from the century which immediately preceded the introduction of railroads, and the construction and maintenance of highways was then an important function of the National Government administered by a vast bureau or department, similar to the Department of Bridges and Roads now maintained in France.

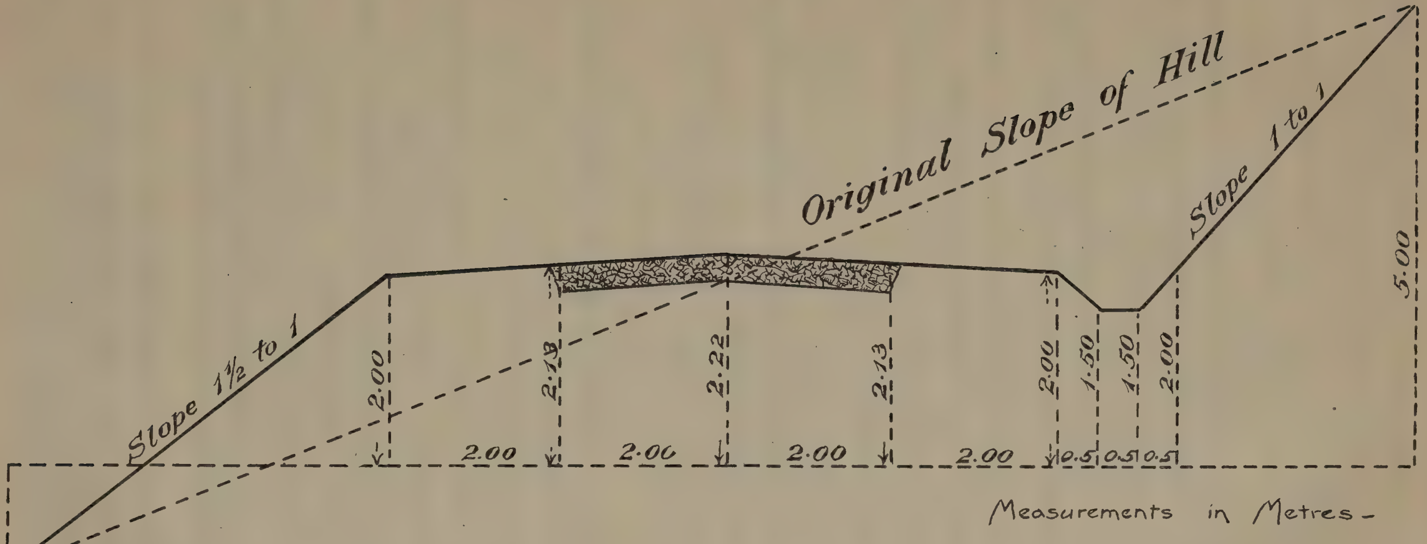
On the organization of the Empire in 1870, the State assumed control of the principal railways, and turned the public roads over to the care of the provinces; consequently, each of the provinces has its separate system of road administration for road construction and maintenance.

In respect to construction, the German process is identical with that of France, skilled engineers having supervision over all work of this nature. The general construction is of Telford, the foundation consisting of stones about 8 inches in height, with a top dressing of basalt, limestone, or other road metal.

Conditions prevailing in Saxony are generally applicable to the other subdivisions of the German Empire, and are about as follows:

The general classification obtaining at present is: (1) State roads; (2) Country roads, connecting two or more towns; and (3) Private ways.

The tolls, which were formerly collected on the State roads and bridges, have been abolished since 1884. Their general supervision and management of construction are intrusted to a State Road Commissioner, the technical direction of the works being in charge of a road director.



Section of
Chemin Vicinal,
Seine-et-Oise.

SHOWING FRENCH MANNER OF CUT AND FILL CONSTRUCTION.

FIG. 1.

Local supervision in the districts is exercised by the "Amtshauptmannschaft," which is the chief executive and ministerial office of the district. The direct technical control, making of plans, engineering supervision, etc., are in the hands of the Inspectors of Roads and Navigable Ways, who must be skilled engineers, and who may make contracts for repairs not exceeding $130. For the execution of larger works the inspector must receive the consent of the Amtshauptmannschaft. A number of State roadmasters are employed, who are charged with the immediate direction of the work of keeping both the State and country roads of their district in repair.

The "connecting," or country, roads are maintained by the parishes through which they pass. The district board is charged with their supervision. Every parish is left free to determine the manner of raising means for defraying that part of the expense of road construction and repair which is not provided for by the State or district. Some parishes have been authorized to levy tolls for this purpose.

The private ways, built by land-owners on their own land, are not subject to ministerial regulations.

In the Kingdom of Saxony the cultivation of trees along the roads has received great attention, and it is stated that in the year 1890 a sum equivalent to over $30,000 was realized from the sale of fruit grown along the State roads in this kingdom.

Square-cut stones, painted white, show distances in kilometres, the figures being cut deeply in the stone.

ITALY.

In Italy the Minister of Public Works has general supervision over the roads, which are classified as:

(1) National roads, which connect the chief cities, and are built and maintained by the Government.

(2) Provincial roads, connecting the capitals of different provinces with the seats of the several districts into which the provinces are divided. The cost of building and keeping up this class of roads devolves upon the provinces, which may levy tolls by royal decree, and they may also levy a per capita road-tax.

The keeping up of such portions of the National and Provincial roads as pass through a city or village falls upon the commune, the government or province paying over annually to said commune a sum equal to the cost of keeping in repair a stretch of road of equal length near the city or village.

(3) Communal roads, connecting the county seats with the other towns in their districts, those which run through villages, etc., the cost of which devolves upon the respective communes; these expenses are paid out of the communal revenues, or by a special tax levied by the

communes, which have the right to establish tolls, the latter being abolished, however, as soon as they have realized the cost of the roads.

These three classes of roads are invariably macadamized.

(4) Vicerial or Parish roads, the care of which falls to the parishes.

SPAIN.

The most ancient Roman road, outside of Italy, was in Spain, and led from Cartagena (Carthage) to the Pyrenees, where it connected with others crossing the Alps to Rome. An ancient document, said to be the itinerary of Antonius Augustus Caracalla, shows the total number of imperial or military highways in the province of Hispania (Spain and Portugal) to have been thirty-four; the total mileage of these roads was 6,926.

Roads are divided into three classes: Those of the first class (National) being 8 metres; those of the second (Provincial), 7 metres, and those of the third (Rural), 6 metres, in width.

In 1842, a law was adopted which brought into existence a national corps of road-builders, who are employed by the State in building and repairing roads.

Each year the amount to be spent on public roads is fixed, and a specified sum designated for each class, the building of roads being let by contract, or performed under the direction of the engineer corps of the Council of Roads, Canals, and Ports.

The Board of Public Works of each province forms and presents to the provincial assembly plans for the improvement and construction of the principal highways. These plans and accompanying memorials are presented to the Ministro de Fomento, who, after consulting the Council of Roads, Canals, and Ports, decides what shall be granted.

The government of the third class, or Rural roads, is mainly under the civil governor of the province, though final appeal may be carried to the Ministro de Fomento.

It can hardly be said that the present road system of Spain is worthy of emulation, as the power of the Ministro de Fomento to intervene in the construction of even the most unimportant local roads has the tendency to destroy the spirit of local enterprise, which, if left to itself, would probably carry out the projects which it initiates. The manner of conducting labor on the roads is extremely primitive, no machinery being used, the material from cuts and for filling purposes being leisurely carried by hand in baskets from one place to another, instead of being hauled by wagon.

SWITZERLAND.

The mountainous nature of the country, and the severe tests to which the roads are put by the sudden swelling of the watercourses, have rendered road-building of primary importance in this country, and the great necessity for international communication from France and German the one hand to Italy on the other, tended to further good road struction at an early period.

There exists to-day as well-known traveled routes a number of th Roman* roads, which have been laid out with as much engineering as could be obtained at the present day. Nor were the Roman valley roads through Switzerland less judiciously laid out, or less thoroughly constructed, for they coincide in the main with the leading railway and post routes of the present time.

In the breaking up of society which followed the invasion of the barbarians and the fall of the Roman Empire, the Roman roads, although in continual use, fell out of repair and finally into ruin. The first great construction of the new era was the Simplon Pass, begun in 1800 by the Emperor Napoleon, and finished in 1804. This was followed by the Bernardino (1818–1821), the Splügen (1818–1823), the Julier (1820–1826), the Maloja (1827–1828), the St. Gothard (1820–1830), the Furka, Oberalp, Albula, Flüela, Bernina, Offenberg, Lukmanier (finished in 1876), and the Brünig. These great mountain roads, with the highways following the watercourses, or traversing the lowlands, form the skeleton of the system to which all the lesser local roads are attached.

Mr. S. Bavier, Minister from Switzerland to Italy, published a most interesting work ("Die Strassen der Schweiz") in 1878, on the roads in Switzerland. He estimates the mileage of turnpikes at that time to have been 8,388, or 3 miles of road to every thousand of population. With justice, Mr. Bavier observes that Switzerland's network of highways, extending even to her remotest valleys, constitutes the pride and glory of the land.

The classification of roads in the canton of Zurich, as given below, is generally applicable throughout the country.

The public roads are divided into three classes: To the first class (turnpikes) belong those roads which serve as the means of communication between the larger sections of the canton, embracing several townships, or connecting with similar roads in adjoining cantons.

To the second class (connecting roads) belong those roads which serve to connect the chief sections of a single township with each other, or with first-class roads, or with railway and steamboat stations.

To the third class (side roads) belong all those roads not embraced in the first and second classes, as well as all public footpaths.

The following authorities are competent to take action with regard to classification, construction, and repair of roads, viz: For first-class roads, the Cantonal Council; for second-class roads, the District Council, subject to the Cantonal Council's approval; for third-class roads, the Township.

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* Among these Roman roads may be mentioned: the St. Bernard, Simplon, Lukmanier, Bernardino, Splügen, Septimer, and Julier roads.

aws are rigidly enforced concerning the construction and mainte-
e of roads, tree-planting, erection of guide-boards, use of wide
s, etc.

UNITED KINGDOM.

ery little art or science in road-making existed in any of the countries of the United Kingdom until about the beginning of the nineteenth century, when John Loudon Macadam and Thomas Telford, both of them Scotch engineers, inaugurated their new systems of road-building, and these are now strictly adhered to as the principal methods of road construction and maintenance.

Over $50,000,000 is annually expended on road construction and maintenance.

ENGLAND AND WALES.

The roads in England were, until somewhat over twenty years ago, under the control and management of turnpike trusts, usually appointed by Acts of Parliament applying to the various districts; these trusts collected tolls and maintained the roads in excellent condition. By Act of 1878 and subsequent Acts of Parliament it is provided:

The duty of maintenance, etc., of highways is cast upon the ratepayers of the parish, and managed by their highway surveyor.

Parishes are united into districts, under the supervision of the highway boards.

In order to raise the necessary funds for the maintenance of the highways, the ratable property value in each parish is ascertained, according to the valuation list in such parish, or, if no valuation list be in force, by the justices of the peace, subject to appeal.

SCOTLAND.

The country road system of Scotland may be deemed as a growth to meet the wants of the public, and its present state of excellence approaches perfection, the Scotch highways being better, as a whole, than those of the other countries of the United Kingdom.

A considerable force of men is continually employed on the roads, the counties being divided into divisions, those being subdivided into districts, and the districts again subdivided into sections, for the purpose of the proper distribution of labor and superintendence, the county surveyor of each county having primary charge of the roads in his county.

A tax-rate of from 6d. to 8d. on the pound (12 to 16 cents on $4.86) is found sufficient for the construction and maintenance of roads.

Toll-roads were abolished by Act of Parliament of 1878 (already referred to under "England and Wales").

Primary importance is given to construction, the roads being built in the most thorough manner, and, by the system of the proper overseeing of roads, the smallest repairs are not neglected until they assume serious proportions, heaps of road-metal being distributed at easy distances along the roads.

Milestones, which are set in such a manner as to indicate directions by their face surfaces, show the distances to the nearest larger towns, and the newer roads are now constructed for the accommodation of the pedestrian, as well as the driver, by being provided with suitable footpaths, built of cinders, slag, or other easily drained material, and as much attention is paid to their maintenance as to other portions of the roads.

The great Highland roads, though traversing wild mountain ranges and stretches of moorland, are excellently constructed, and easy gradients have everywhere been secured.

IRELAND.

In Ireland, the construction and maintenance of public highways are regulated by the Grand Jury, the counties being divided into baronies, in each of which a Grand Jury Presentment Sessions Court is held biennially, which approves or rejects applications for the construction of roads and bridges, or for the maintenance of existing roads, the County Surveyor meanwhile having prepared plans, specifications, estimates, etc., covering the proposed work, this officer having supervision over all actual work on the highways and bridges. The work, if approved, is let by contract.

Each barony supports its own roads and bridges, except mail-post roads, which are charged one half to the barony and one half to the county at large.

SUMMARY.

At a glance at the conditions narrated in the preceding pages as prevailing in our own country and in Europe, the conclusion is self-evident—that only those States and Countries which exercise a high *central controlling power* over their road and bridge systems have made any advance in the direction of road improvement, and that the *classification of roads*, each class directly governed by a power proportionate to its importance, forms an important feature of highway legislation and management.

The necessity for the employment of proper *engineering skill and superintendence* for purposes of construction and maintenance is also self-evident; and, in this respect, the impracticable, useless, and haphazard system (or lack of system) of tearing up and patching, in vogue in many of our States, cannot be too strongly condemned as a useless and extravagant expenditure of money, whereby no lasting results are obtained.

To the credit of California, be it said, that these two essentials—a controlling power and road classification—have received legislative attention—first, by the creation of the Department of Highways, and, second, by the designation of certain roads as State Highways; and, with the proper extension of these functions, a permanent system of excellent highways is assured to California.

The excellent highways of Austria, Belgium, France, Germany, Switzerland, and the United Kingdom are attributable to the existence of a proper controlling State or Governmental authority.

State commissions are in existence in the following States: California, New Jersey, Massachusetts, Connecticut, Rhode Island, New York, and Vermont; and the following States may be mentioned as closely following in this direction: Georgia, Kentucky, Indiana, Maryland, Minnesota, New Hampshire, Ohio, Pennsylvania, West Virginia, and Wisconsin.

ADVANTAGES OF GOOD ROADS.

When poor roads prevail in any section, everything else is very apt to be poor—the farmer, the horse, the merchant, the schools. Every day that the public roads are allowed to remain in a poor condition and the streams to remain improperly bridged, the community deals a direct and severe blow to its own interests, and the country will remain undeveloped, its hidden treasures locked up. These roads, if improved and properly engineered, with permanent bridges constructed, would give some signs of permanence of settlement and of contentment with the section; they would induce new settlers to remain; the burden of tax would soon rest upon so many that the roads would be almost self-sustaining; the saving in horses and running-gear would be enormous, and the increased loads that could be sent to market, with a decreased power for draught, would form a substantial increase to the farmer's income. In short, there are few blessings that any community can know equal to that of having first-class roads.

The matter of increased haul is treated of under the heading "Traffic on Country Roads." (See pp. 67–68.) And in this connection, it can truly be said that the United States is handicapped in all the markets of the world, by an enormous waste of labor in the primary transportation of our products and manufactures, while our home markets are restricted by difficulties in rural distribution which not infrequently clog all the channels of transportation, trade, and finance.

It is indeed "passing strange" that we, as a nation, excelling all others in the matter of public improvement, should have the poorest road-system of any stable government.

John Gilmer Speed, in an article on the question of "The Common Road as a Social Factor," says:

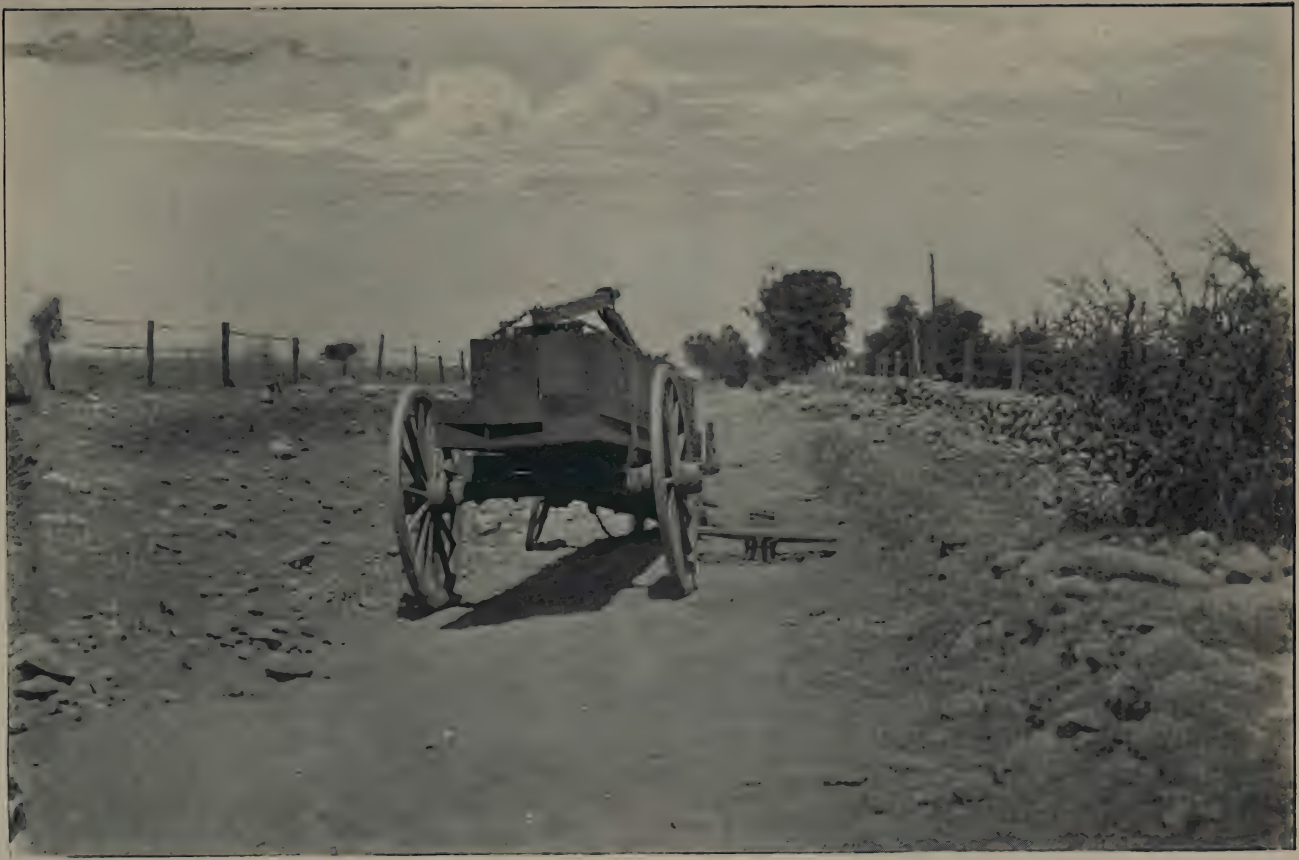
> If the common roads had been properly laid out, constructed, and attended to, and their development had kept pace with the development of other highways, I suspect that we would now have other problems to solve than those that confront us.
>
> * * * * * * * * * * * *
>
> We should not have a dissatisfied agricultural population, worried by debt and harassed by care, so that any demagogue with a promising nostrum is listened to with enthusiasm and respect; we should not have the countryside suffer because of a lack of labor, and the poor in the crowded cities suffer from a lack of work.

When the Department of Agriculture, through the Office of Road Inquiry, took up the matter of investigating road conditions in foreign countries, one of the questions asked of our various Consuls was as to what effect improved roads had in increasing land values, etc., and some of the answers given are quoted:

"It is difficult," writes one of our English Consuls, "to arrive at any fact in dollars and cents, relative to the effect of improved public roads upon the value of land or other economic condition, but the effect of such roads now, and for so long in existence, is seen on every hand, and the influence felt in the English mode of life. Englishmen, be they of the gentry or of those in the humbler walks of life, seek their pleasure in and gladly betake themselves to their country homes. The one medium of this pleasure so natural to all men is the solid roadbed over which one can walk, or ride, or drive with equal comfort or pleasure any day in the year."

From Germany comes the response: "It depends on the state of roads to improve the soil, to put to profit the forests, mines, and industrial plants." How applicable are these few words to California! The farmer, with his acres of grain and his orchards of the finest fruit produced in the world, stands as the backbone to our prosperity; the stock-raiser, with his herds of cattle, summered in the lofty Sierras, and driven to the valley for protection during the winter; the mining man, whether exploring for the untold wealth of precious metals that probably yet remains to this day undisturbed in California, or whether taking from its underground channels oil, petroleum, and other natural products in which the Golden State so abounds; the lumberman, felling the timber in our high mountains, all demand good roads.

Of France it is said: "The road-system of France has been of far greater value to the country, as a means of raising the value of lands and of putting the small peasant proprietors in easy communication with their markets, than have the railways. It is the opinion of well-informed Frenchmen who have made a practical study of economic



Effect of Bad Roads. Road Located Below Natural Surface of Country. No Attention Paid to Grading or Drainage.

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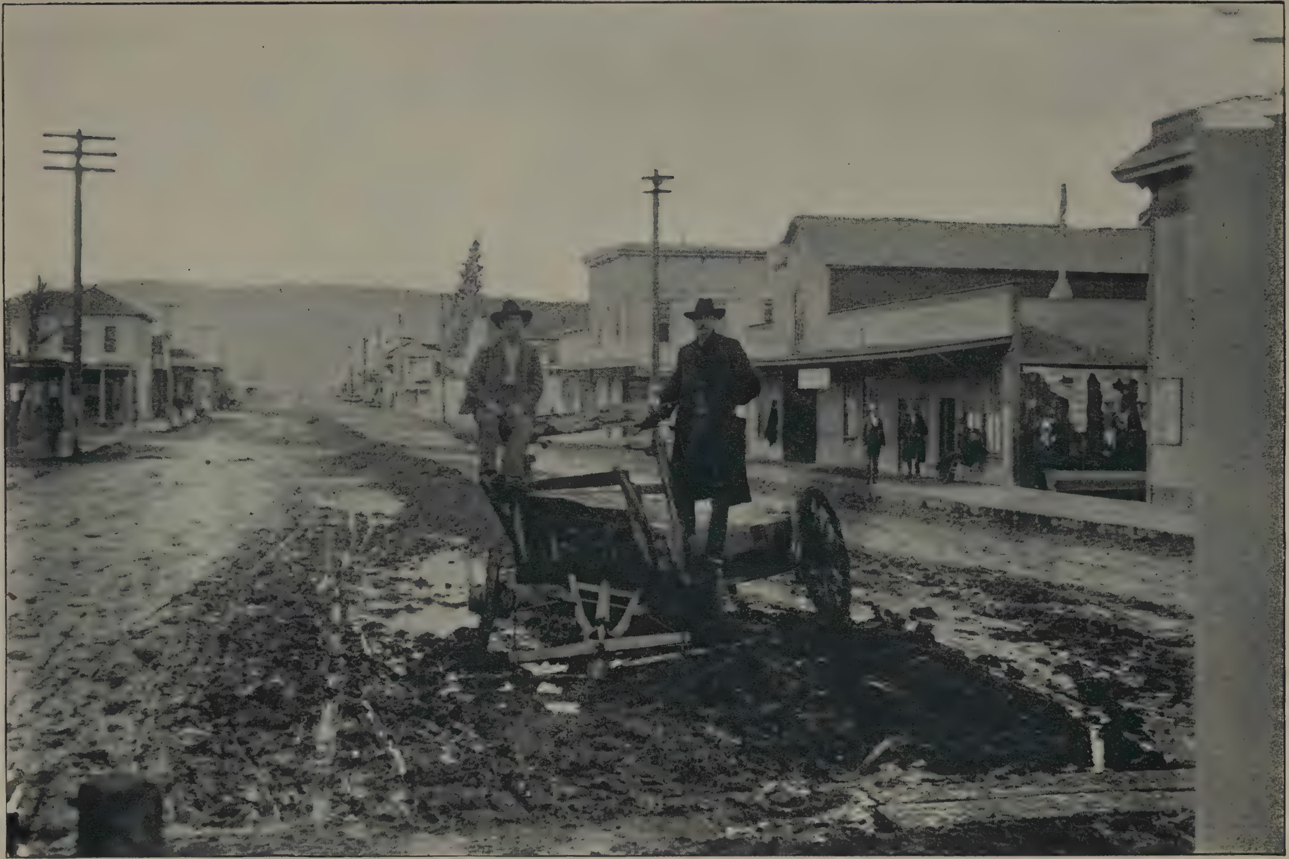

Muddy and Ill-Drained Village Street. Vacaville, California.

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problems, that the superb roads of France have been one of the most steady and potent contributions to the material development and marvelous financial elasticity of the country."

On the "social side" of the road question, Mr. W. H. Moore of St. Louis, Mo., writes:

> The common roads of a country are not only necessary to its development, but their condition is a measure of its civilization. The highest type of mental and moral culture and development cannot be attained without the means of easy and rapid communication between all parts and sections of the country. The railway and telegraph lines are the great modern civilizers of the world; but they are limited in their sphere of usefulness, because they do not reach the farm, the home, the country school-house and church. The common road is the connecting link between these, and without it the progress of a widespread civilization must of necessity be greatly retarded. They are the foundation stones upon which the superstructure of society is erected, and upon which its symmetry, beauty, and stability must rest.
>
> It has been stated by eminent writers that railway and telegraph lines, with the wonderful commercial enterprises they make possible, are in the end detrimental to a country that has no proportionately adequate system of common highways, because of their tendency to congest the population by drawing the intelligent and ambitious portion of the country youths to the cities and centers of commercial enterprise, until the avenues of that class of labor are overcrowded, the wages of labor decreased by undue and unnatural competition, and the surplus set adrift without the means of a livelihood, to become beggars or criminals, instead of delving in the soil from which the primary wealth of the world is secured, and in which avocation there has never yet been a surplus of labor.
>
> Then, too, it is the youthful, intelligent, rugged, and ambitious who are thus being coaxed from the farm, whose society is needed to stimulate the sluggish, who are always content to see the world's great cavalcade go by while they remain in slothful isolation. If these conditions continue, there is danger of a barrier being built up that will destroy that sympathy, intelligence, and coöperation that is so necessary in our mutually dependent condition.
>
> Neighborhoods, counties, and states, separated from each other by barriers of practically impassable roads, in their loneliness degenerate into a condition of moral stagnation, from which it is difficult to arouse them to a common and mutual interest and understanding.

We have already dwelt upon the financial gain to the farmer living in a community where good roads are prevalent, in the way of easy access to markets and shipping points. Viewing the question of road improvement from whatever side one will, its financial advantages can be so strongly set down in facts and figures that they are bound to appeal to any one. When we consider that practically every pound of freight carried by our railroad and steamship lines has previously had to undergo transportation over our country roads in one form or another, is it any wonder that the greatest railroad financiers and managers are strongly in favor of the good-roads movement, and are willing to lend a helping hand to those communities who are alive to their own interests, and who wish to rise up and throw off the yoke of the demon mud? The Office of Road Inquiry has in recent years gone fully into this question, by correspondence with many of the railroad companies of the United States, and some of the letters received by the Department from railroad officials are well worthy of passing note.

A North Carolina official writes, stating the willingness of his railroad to encourage road-building as much as possible, by reducing their lowest freight rate 50 per cent for the transportation of road material, and adds: "The people of our section of country are far from being a prosperous class, and I am afraid it will be long before they will appreciate the importance to them, and the actual saving to them from a pecuniary point of view, to be had from properly constructed roads."

One of the Florida railroads presents a schedule for the transportation of hardpan (which had been found a very useful top-dressing for the sandy roads of that section), varying from one to four cents per ton per mile, according to haul, the rate increasing with decreased length of haul; for example, per carload of 24,000 pounds, distance of 10 miles and under, the rate is $5; between 50 and 60 miles, $11 per carload; between 100 and 110 miles, $15 per carload; between 150 and 160 miles, $18 per carload of 24,000 pounds. And these rates may be given as the general average of figures quoted by other roads, though some have gone so far as to grant free transportation of road-building material in certain cases. The President of the road in question states that "rates quoted have been slightly shaded on account of the interest which the railway has in the progress and prosperity of settlements in a comparatively undeveloped state."

From other railroads in Florida and Tennessee numerous letters of encouragement were received, with offers of liberal reductions in rates for the transportation of road material.

The Superintendent of an Alabama railroad writes: "We shall be pleased to offer special inducements in the way of freight rates, etc., looking to the betterment of public roads, if called upon to do so."

The General Freight Agent of one of the Vermont lines writes, offering half rates for the transportation of road material, and says: "This company is in hearty sympathy with the movement, and, when the time comes, will endeavor to do its share in the good work."

One of the officials of a Kentucky railroad presents a most elaborately prepared table, showing the location of road material along his line, together with the approximate cost of loading the same on board the cars, and further offers the hearty coöperation of the railroad; and an interesting letter along the same lines comes from a Florida railroad official.

The opinion of the Chief Engineer of a prominent railroad in Indiana is worthy of note. He states: "One of the chief obstacles in the way of advancement toward perfecting good roads is the lack of knowledge on the part of persons directing their improvement." He suggests that the fundamental principles of road construction be taught in the public schools. "Teach the boys," he says, "that railroads and steamship lines are the main arteries, and highways the lateral arteries, of commerce, and that it is of great importance that the latter be kept up in good condition. Instruct them at the same time how to make and maintain them, and I do not know of anything that will promote faster the improvement of our highways."

The General Manager of one of the leading railroad lines, with headquarters in St. Louis, Mo., writes that in some instances very low rates have been made for the transportation of road material, and, as a general proposition, his line is willing to haul this character of material on the basis of the cost of service for short distances, and for longer distances on the basis of one half cent per ton per mile.

The Chief Engineer of one of the principal railroads in Illinois recommends radical changes in the organizations looking after public highways, and strict engineering supervision over the construction of roads. He favors the imposition of a direct money tax, and condemns the labor system, recommending the improvement of the highways connecting the principal towns as the initial system, after which the construction of lateral and branch roads should be taken up. The President of the same railroad writes: "We have at times made reduced rates in special cases, to encourage the building of roads in which our company was vitally and directly interested. * * * We have also in several cases paid our local taxes for perhaps a year, or two years, in advance, by furnishing materials from the company's gravel pits and transporting the same." He recommends legislation whereby the railroad companies may be allowed to furnish such material and transportation in lieu of taxes, *in advance* of the time when the taxes become payable, and adds that the road question should be taken up by the Federal Government and by each individual State on as broad grounds as its interests may dictate. "The reason for the present bad condition of highways in many parts of this country seems to me to lie in the lack of coöperation over sufficient areas, each little township working in its own interests, regardless of those of its neighbor, and each land-owner working out his tax on the road at the season of the year it suits him best, and in a way which his ignorance of the importance of the subject leads him to think cheapest. While I do not profess to have any knowledge of what the best system is, I am clear that nothing could be worse than the present *lack* of system. You are perfectly right in referring to the interest uniformly shown by railway managers in the improvement of highways."

From Michigan come responses, agitating legislation putting the control of roads under a State commission.

In California, the Southern Pacific Company has accorded most liberal reductions for the hauling of the output of the rock-crushing plant at Folsom.

And not alone does the farming, or country, community reap the benefits of good roads. Money paid out among the farmers is applied to the fountain-head of all business, and from there it will ultimately flow downward, filling all the channels of trade, production, and finance. The commission men in our cities, handling the immense output of fruit from our orchards; the grain-brokers, buying and shipping our wheat; the transportation companies, shipping the products of the farm by rail and water; the wagon-makers and implement-dealers, supplying the farmer; the commercial world, trading with the farmer; the public at large, enjoying the benefits of good city markets, accessible from the country, where fresh farm produce can be purchased at reasonable rates; the wheelman; the tourist; the owner of driving and riding stock, or horseless carriages—all will receive their full share of the benefits.

Another direct benefit to the land-owner is the increase in the value of property resulting from highway improvement. Granting that increased land value means increased taxation, would the farmer who has once enjoyed the benefits of good roads be willing to retrograde, to give up the pleasures he derives from good highways, to decrease his earnings by the necessity of a larger outlay for horses and rolling-stock, and to adopt the "penny-wise and pound-foolish" system, just to save a few dollars in extra taxation? If there be such a one, let him sell his farm at its advanced value, and betake himself to some native wild whose tranquillity has never been troubled by the spirit of progress.

A most interesting phase of the road question, with respect to its advantages, socially and morally, has been applied to it by the Government, in the question of free rural mail delivery. The Postoffice Department, which has reached a wonderful degree of perfection in the United States, stands ready and willing at all times to give equal service to all classes and to every section of the country in the distribution of mails, provided the department can do so within the restraints of its appropriations and incomes. The educational influence of the daily paper, the ability of the farmer to keep in constant touch with the market fluctuations and prices, and other comforts and conveniences, would naturally follow in the wake of free rural delivery.

First Assistant Postmaster-General Perry Heath, who has been an earnest advocate of the establishment of a system of free rural delivery, after citing the advantages, in the way of increased value of farm lands reached by mail routes, and in the tendency to improve roads that would naturally follow, writes:

> To these material advantages may be added the educational advantages conferred by relieving the monotony of farm life through easy access to wholesome literature and the keeping of all rural residents, the young people as well as their elders, fully informed as to the stirring events of the day. The moral value of these civilizing influences can not be too highly rated.

As a partial solution of the labor problem, also, the road question presents itself. The number of idle men, forced to beg and, almost, to steal to "keep the wolf from the door," would be materially decreased; the public wards of charity and the inmates of our county jails and state prisons would be lessened, were a broad and liberal system of road-building and improvement introduced.

And, in conclusion, again quoting from Mr. W. H. Moore's able remarks on "The Social, Commercial, and Economic Phases of the Road Subject":

> The road question is resolving itself into a plain problem of competition. The State or Nation that does not build modern ways of communication can not successfully compete in the markets of the world. * * * Every State of the Union should have a settled policy on the kind of roads it shall construct, and every county see to it that no citizen be allowed to represent it in the legislative halls of the State without a pledge to work faithfully for the enforcement of such policy. Then, and not until then, will the condition of our public roads cease to remain discreditable to our country and a menace to our further development and civilization.

THE CONSTRUCTION AND MAINTENANCE OF ROADS.

LOCATION.

The first and most important object to be considered is that of location, which is too often done in a haphazard manner, ultimately leading to expensive maintenance.

Under this heading must be considered, primarily, the points to be connected and the topographical features of the country to be traversed. It is only in very rare and exceptional cases that a road location can be advantageously traced in a direct line between two points, even when they would be separated by but a short distance. It is generally necessary to deviate in order to avoid difficulties, to take advantage of the most economical location for bridges, and, if possible, to so locate the road as to the adaptability of the country for good roadbed, preference being given to location which will bring into proximity supplies of road-building material, such as gravel beds, stone deposits, etc.

GRADES.*

It is hardly realized that only 41 per cent as much can be hauled on a grade of 5 feet per hundred as on a level earth road; that on a 10 per cent grade this is reduced to 26 per cent, and to 10 per cent on a grade of 15 feet to the hundred; or, to put it in another way, the energy required to haul a given load one mile on a grade of one foot to the hundred is the same as is required to haul the same load a mile and a half over level road, while this increases to three miles and a half on a 5 per cent grade, and to six miles on a 10 per cent grade. *The profile and alignment of a road should be a compromise between directness of route and an easy gradient.*

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*See Tables of Grades, pp. 66–67 of this Report.

The saving in maintenance of a road, if properly graded, is also very considerable, as the velocity of storm-waters is naturally lessened by a decrease in gradient, thus reducing the danger of washouts and the expense of repairing the same.

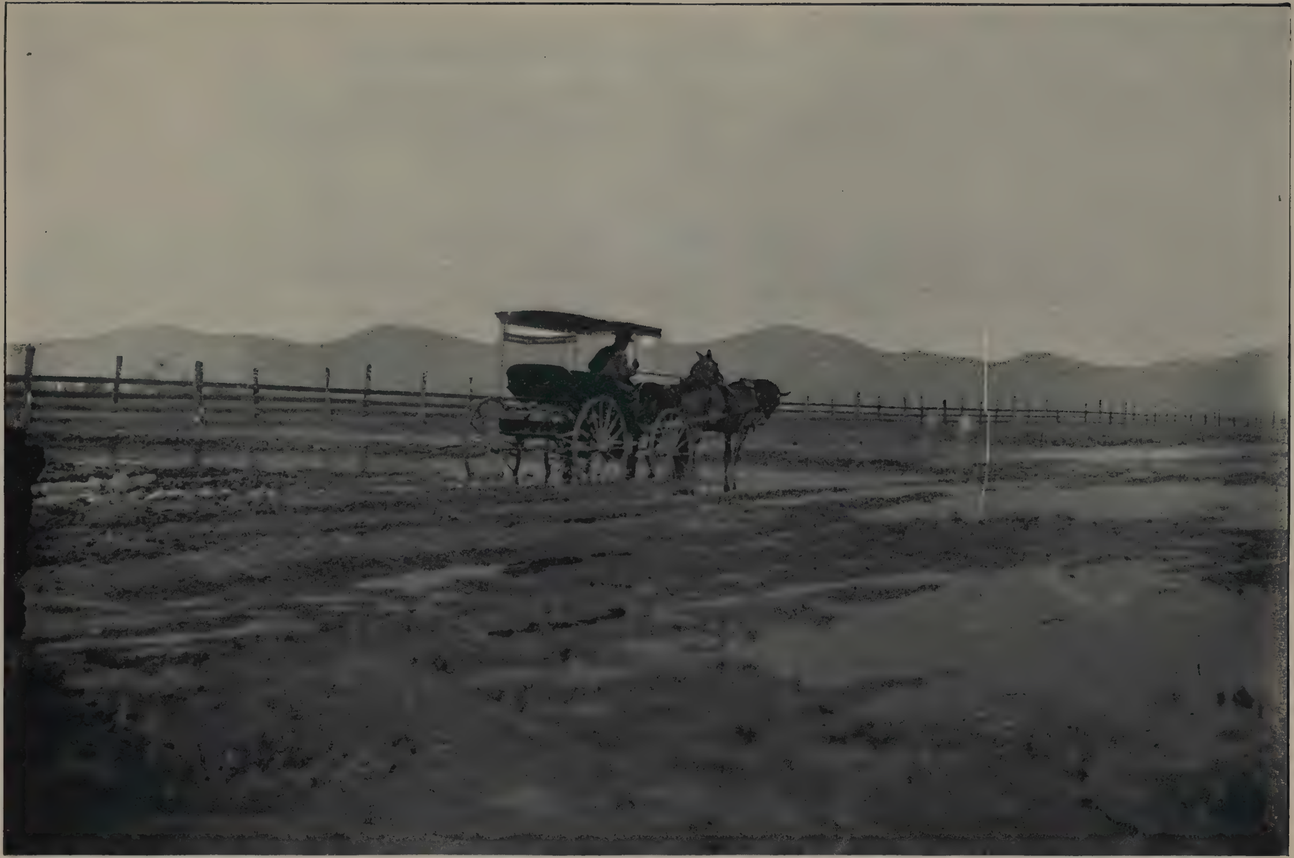
It is therefore well for the road-builder to bear these figures and facts in mind, and to consider them in road location. The primary cost of the construction of a road, located with due regard to gradient, even in the most unfavorable locality, where materials and labor are high, is of but little consideration as compared with the immense saving gained by increased load and lessened energy necessary to haul.

It is a hard matter to set down in exact figures the maximum grade that should be followed, as authorities, though agreeing on the fact that the less the grade the more economical is the road, differ as to what should be exactly the greatest allowable grade at all consistent with proper economy in maintenance, but it is generally considered that the grade should not exceed 1 in 40, or 2½ per cent, if it can possibly be avoided. But in no case should a properly constructed highway, whatever the conditions be, have gradients in excess of ten feet to the hundred, and this only in very short stretches. It is also argued by many that a rolling road—that is, one having very slight grades up and down in alternate stretches—is preferable to one constructed on a dead level, inasmuch as the slight grade facilitates drainage of surplus water.

DRAINAGE.

Due care must be exercised toward drainage of the roadway, proper regard being given to adjacent property, in order that storm-waters may not cause damage to cultivated lands, etc., adjoining the roadway, and that the overflow may be disposed of in such a manner as not to stand in the side ditches, causing damage to subgrade, but that it be conveyed to the nearest natural watercourses, if possible; and especially should the matter of thorough drainage receive attention where the road is entirely "in cut," bringing the surface of the road below the natural level of the adjoining country. This can be accomplished by digging side ditches of proper slopes (not steeper than 1 foot vertical to 1½ feet horizontal) to convey the water until it can be disposed of. (See Fig. 2, which illustrates this method of side-ditching.)

These ditches should be carefully looked after, to see that they do not get choked or washed away, and, so long as the natural growth of grass on their sides and bottom does not interfere with the free passage of



Type of Poorly Drained Road. Kern County.

water, the roots and sod should be allowed to remain, as they form a natural lining to the ditch, and prevent an excessive percolation of water. Weeds, however, should be cut, particularly large and noxious ones.

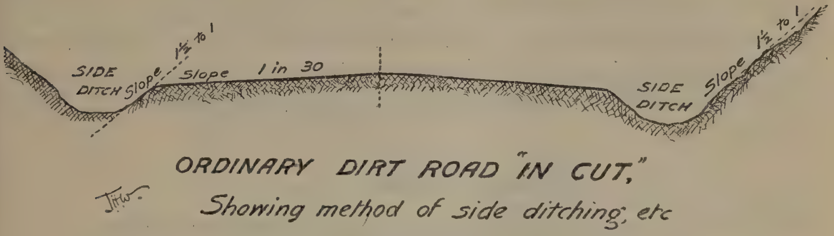

SIDE DITCH
Slope
1½ to 1
Slope 1 in 30
SIDE DITCH
Slope
1½ to 1
ORDINARY DIRT ROAD "IN CUT,"
Showing method of side ditching, etc

FIG. 2.

In soil of a boggy nature (which, however, seldom occurs in California), and where expense will permit, "blind" drainage is advocated, constructed in the following manner: A side ditch should be dug to a depth of 2 to 3 feet below the center of the road. In the bottom is placed a 6-inch vitrified pipe, surrounded by broken stone and covered with dirt. Second quality of pipe may be used, and on account of 6-inch pipe being a standard size, there is always a large surplus of "seconds" available, which the manufacturers are willing to dispose of cheaply. Care must be exercised in the proper laying of the pipe, an even grade being maintained and the joints properly made. If pipe cannot be secured, flat stones can be laid in such a manner as to form a fairly good drain, but precaution must be taken to avoid the danger of scouring at the bottom of such a drain, as a cave-in will result, with consequent clogging of the ditch.

The accompanying diagrams illustrate various styles of drains and culverts.

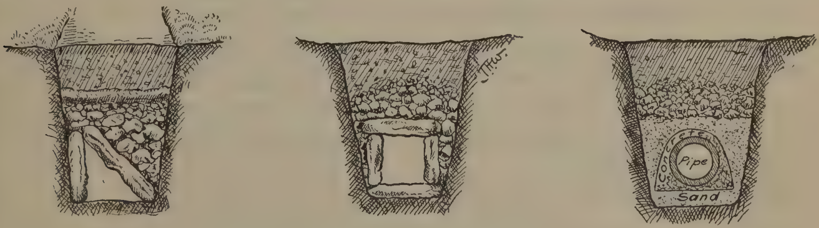


FIG. 3. Various types of drains.

Where the road lies along a fill, the proper rounding of the roadbed will, of course, dispense with the necessity of side drains for surface water, but provision must be made for underdrainage at the base of the fill, by pipes or culverts, in order that the roadbed may not form a dam for underground water; and it must be seen that sufficient slope is given to the sides of the fill to prevent washing. The inclination should not be over 45 degrees.

When the road is partly in cut and partly in fill, as in the case of a hillside road, the outside water will take care of itself, but side drains should be placed on the inside (or cut) and relieved of their water by cross-drains running across and underneath the roadway at intervals. These should be constructed, if possible, of vitrified pipe, laid in the manner already described, or, where the volume of storm-water is such as to demand it, larger culverts should be placed. Suffice it to say, that it is invariably cheaper to build these of a substantial and lasting character.

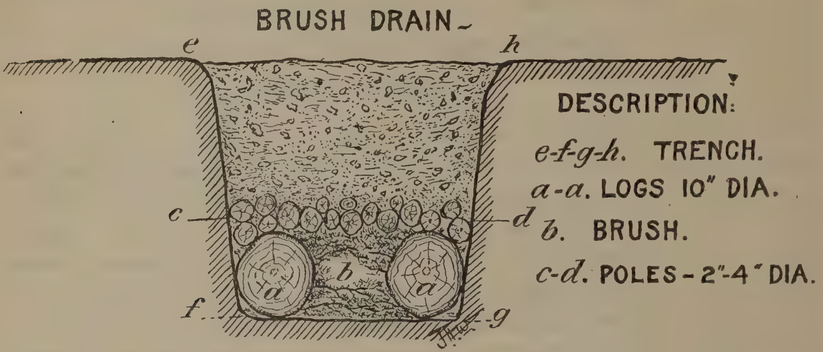


FIG. 4.

ABUNDANCE OF ROAD MATERIAL IN CALIFORNIA.

Along practically all of our mountain roads, stone is abundant, and can be used in the form of dry masonry for culverts and retaining walls. Yet, we see this natural store of material too often ignored, and expensive wooden culverts built (usually unnecessarily large), lasting, at the best, for only a few seasons, to be rebuilt in the same manner as before. If local overseers of roads were only to exercise some ingenuity in the way of applying to roads the materials which nature has so lavishly provided in most localities of this State, a wonderful degree of betterment at a slight expense—in fact, at an actual saving—would be attained, and the constant necessity for patching and repairing would be greatly diminished.

The following table, naming some of the road-building material occurring in each county in the State, has been compiled by the Department after careful examination of the localities mentioned. It is by no means exhaustive, but is sufficient evidence of the great store of road-building material lying within our State:

Alameda	Chert, limestone, basalt, trap, and metamorphic rock; gravel.
Alpine	Basalt, silicious and metamorphic rocks.
Amador	Bowlders, cobbles, gravel, limestone, basalt.
Butte	In mountainous portions, large variety of stone; in valley portions, clay, gravel, sand.
Calaveras	Basalt, limestone, cobbles, bowlders.

Colusa	Basalt, lava, gravel, sand, clay, hardpan.
Contra Costa	Basalt, limestone, chert, jasper, gravel, shale.
Del Norte	Bowlders, cobbles, silicious and metamorphic rocks; gravel.
El Dorado	Volcanic and metamorphic rocks, basalt, limestone, gravel, cobbles, bowlders.
Fresno	Gravel, hardpan, sand, clays; volcanic rocks in mountains.
Glenn	Gravel, trap, basalt.
Humboldt	Gravel, trap, basalt, limestone, bowlders, cobbles; some asphaltum.
Inyo	Silicious and volcanic rocks; gravel, clay.
Kern	Bitumens, asphalts, clays, adobes, sand, volcanic and metamorphic rocks.
Kings	Asphalts, volcanic rocks, clays, sand.
Lake	Trap, basalt, shales, gravel.
Lassen	Basalt and other volcanic rock; limestone, gravel.
Los Angeles	Disintegrated granite, porphyry, limestone, gravel, cobble, clays, etc.
Madera	Gravel, clays, adobe, sand; volcanic rock abundant in mountainous portion.
Marin	Basalt, trap, gravel, metamorphic rock.
Mariposa	Quartzite, volcanic rock, gravel, metamorphic rock.
Mendocino	Basalt, trap, silicious shale, etc.
Merced	Sand, alkaline clays, adobes, gravel.
Modoc	Basalt, trap.
Mono	Metamorphic and silicious rocks.
Monterey	Bitumen, limestone, gravel.
Napa	Volcanic rocks, including basalt; gravel, silicious shales.
Nevada	Volcanic and metamorphic rocks; gravel, cobbles, etc.
Orange	Gravel, asphalt.
Placer	Basalt, trap, limestone, shale, bowlders, cobbles.
Plumas	Volcanic and metamorphic rocks; gravel, silicious shale.
Riverside	Porphyry, limestone, disintegrated granite, metamorphic rocks.
Sacramento	Cobble, bowlders, gravel, trap, granite.
San Benito	Shale, volcanic and metamorphic rocks, limestone.
San Bernardino	Limestone, bowlders, gravel, clay.
San Diego	Cobbles, gravel, bowlders, limestone, basalt, trap.
San Francisco	Chert, jasper.
San Joaquin	Volcanic rocks, gravel, clays, adobe, sand, hardpan.
San Luis Obispo	Bitumen, asphalt, trap, shale, chert, gravel.
San Mateo	Chert, limestone, bowlders, jasper.
Santa Barbara	Cobbles, bowlders, gravel, limestone, bitumen, asphalt.
Santa Clara	Gravel, asphaltum, volcanic and metamorphic rocks, jasper, silicious shales.
Santa Cruz	Volcanic, metamorphic, and bituminous rocks, gravel.
Shasta	Gravel, bowlders, cobbles, volcanic rock.
Sierra	Volcanic and metamorphic rocks, cobbles, bowlders, gravel.
Siskiyou	Trap, basalt, quartzite, limestone.
Solano	Excellent basalt, gravel.
Sonoma	Basalt, trap, gravel, cobbles, bowlders.
Stanislaus	Gravel, clays, sand, hardpan, bowlders, cobbles.
Sutter	Clays and adobes, sand, cobbles, bowlders, volcanic and metamorphic rocks.
Tehama	Basalt, trap, cobbles, bowlders, gravel.
Trinity	Volcanic and metamorphic rocks, bowlders.
Tulare	Alkaline clays, adobes, sand.
Tuolumne	Quartzite, volcanic and metamorphic rocks.
Ventura	Cobbles, gravel, asphalt, bitumen, limestone, silicious shale.
Yolo	Gravel, cobbles, bowlders.
Yuba	Volcanic and metamorphic rocks; cobbles, gravel.

To sum up what has already been said regarding location, drainage, etc., before starting on the actual construction of the road itself:

(1) See that proper drainage is provided;

(2) Remember that economy in maintenance depends on an easy gradient; and

(3) Remember that hilly roads are full of danger, expensive to maintain, and destructive to horses.

These preliminary provisions having been carried out, the actual roadbed should be graded up to a proper convexity and thoroughly compacted by rolling, either by horse- or steam-power.

CROWN, OR CONVEXITY, OF ROADBED.

The crown of the road, or slope from the center to the sides, is merely for the purpose of insuring proper drainage by providing a way by which the water will be carried to the side drains; and, if a reasonable height of crown is exceeded (as is very often the case) the tendency is to throw passing traffic toward the sides of the road, where large, flat surfaces are formed, in which the water collects and stands, leaving a high ridge in the center. On ordinary dirt roads, it is generally considered that the slope from the center to the sides should not exceed half an inch to the foot, while this should be lessened on macadam roads to a third of an inch, increasing slightly with the grade. That is, on a dirt road 16 feet wide, the slope should be 4 inches from crown to ditch, and on a macadam road of the same width from 3 to 4 inches is all that is necessary; the "crowning" of the roadway decreasing with a decreasing grade. In other words, the slope of the crown should exceed the grade of the road, in order that surplus waters may run to the side ditches rather than down the roadway.

WIDTH OF ROADS.

The width of the road naturally depends upon the amount of traffic likely to pass over it; and, in the construction of country roads especially, width is too often given precedence over length; that is, we too often meet with comparatively unimportant roads, say, 30 feet wide, or over, only half worked over their entire width, when 8 or 16 feet of *surfaced* roadway would answer all purposes of traffic, and could be thoroughly kept up at the same or less cost. (It is recommended that multiples of 8, rather than multiples of 10, be considered as standard widths for roads, the reason being that 8 feet is generally considered the space taken up by the ordinary wagon in traveling, so that a 16-foot roadway gives room for two wagons to pass, and on a 20-foot surface there is a useless surplus for this purpose.) The right of way secured, however, from fence to fence of adjoining property, should never be less than 30 feet, as future development of the country traversed is likely to lead to serious expense for further condemnation unless a sufficient width of roadway is secured in the first place. This width will allow for the proper construction of side ditches and foot- or bicycle-paths, besides leaving 20 feet of driving space, of which it is necessary to surface, in some cases, only a very small portion. Of course, the surfaced space should be proportionate to the amount of traffic passing over it. Where the travel is light, the surfaced portion need be but 8 feet wide, but where there is a larger amount of traffic, which would necessitate a too frequent turning out of passing vehicles and a consequent wearing of the dirt shoulders, this width should be increased to 16 feet, which will generally answer all purposes, even on the most frequently traveled country roads.

DIRT ROADS.

In the construction of what are commonly known as dirt roads, the nature of the soil exposed in grading and cutting should be carefully studied. Ordinary earth, when properly packed, will stand considerable wear; but, where soft clayey substance is encountered, provision should be made for some kind of surfacing, and especial attention paid to subdrainage. Sand is often used for this purpose, and if properly laid, mixed, and rolled, forms a fairly good road surface. Gravel, however, is preferable; but, in laying this, it should be seen that no stones of excessive size, such as large water-worn cobbles, are used, and it is well to allow some binding substance to adhere to the stones in order to secure firmness and cohesion. (See article on "Gravel Roads.") As has already been pointed out, the conditions in California are favorable to road construction and maintenance. Nature has been extremely lavish in providing natural road material throughout the State, and even the most remote country roads are seldom far removed from sources of good road-building material.

STONE ROADS.

What has been said above, as to drainage, etc., applies also to roads that are to be surfaced with road-metal. Experience has proved that there is no more general cause of the destruction of roads than soft foundations. A firm, dry, and solid substratum is absolutely necessary for the surfacing material to rest on.

In surfacing a road, the broken stone or other material used is merely a protection or roof to the foundation, and, while the surface receives the wear of passing vehicles, the weight is borne by the foundation, which, if improperly constructed and not thoroughly drained and packed, will be upheaved and depressed, no matter how much care has been exercised in the actual work of surfacing. Therefore, the foundation is of the utmost importance, and should be thoroughly drained, packed, and settled before any surfacing material is laid, and, especially in the case of deep fills, it is advisable, if possible, to let them become perfectly compact by the action of traffic and the rains before surfacing is attempted. If it is found impracticable to delay surfacing for a season after the fill is made, every precaution should be taken to guard against uneven settling. The earth should be spread on in layers of not more than a foot in depth, and rolled and tamped as solidly as possible.

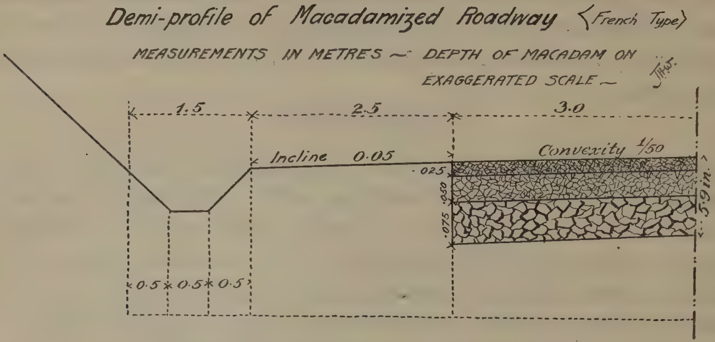

Demi-profile of Macadamized Roadway (French Type)
MEASUREMENTS IN METRES ~ DEPTH OF MACADAM ON EXAGGERATED SCALE ~
J.H.W.
1.5
2.5
3.0
Incline 0.05
Convexity 1/50
.025
.050
.075
5.9 in.
0.5
0.5
0.5

FIG. 5.

The foundation should be conformable in convexity to what will be the surface of the road when completed; that is, the thickness of the surfacing material should be uniform throughout the width of the road.

In regions where stone is abundant, there has been found no material so well adapted to the surfacing of country highways. Macadam's principle was to "put broken stone on a road which shall unite by its own angles, so as to form a solid hard surface."

The stones should be so laid that the entire width shall form the segment of a flat ellipsis, the arch of which shall be of the proper convexity, so as to assist the water to pass from the center to the sides, and thus contribute to the drying of the road, by allowing the action of the sun and air to produce a great degree of evaporation.

As the principle of Macadam is to unite the stone by its own angles, the broken rock should be spread in layers of even sizes, starting at the bottom with a course of stone not over 2½ inches in diameter, and not smaller than 1½ inches. This insures thorough packing when rolled, as the larger stones will fit one another more closely than if mixed with the smaller. After the roadbed has been thoroughly prepared for the reception of the road-metal, the No. 1 (or larger) stone should be laid on it to a depth of 4 to 5 inches. It should be carefully spread by shovel, and not carelessly dumped out of the carts on to the roadbed. This should be well rolled until an even surface and a uniform thickness of stone are obtained over the roadbed. When properly rolled, the stones will form a layer about one fourth less in thickness than when laid loosely by shovel; in other words, if 4 inches of No. 1 stone are laid by shovel on a foundation, this should shrink to about 3 inches after proper rolling. After the first layer has been thoroughly rolled, the second layer, of stones from ¾ to 1½ inches in diameter, is laid on in the same manner as the first, and, when rolled, should be about 2 inches thick. Too much stress cannot be laid on proper rolling. Roll and re-roll until thorough compactness is secured. Do not roll from the crown of the road, but start on the sides. On top of the No. 2 stone is finally placed the binding course, or screenings, which should be wet down and rolled. Care must be observed in wetting down that too much water is not used, as this has a tendency to wash the foundation.

The following rules for the construction of stone roads have been compiled and issued by the Massachusetts Highways Commission, and are well worthy of careful study:

When possible, roll the sub-grade with a steam-roller.

If the sub-grade is too sandy to roll, cover with coarse gravel laid on to a depth of 3 inches, or as much more as may be needed to give a good foundation. Fill any depressions with the same material till the surface is true and even.

All broken stone must be rolled in screened layers.

After spreading the first course of broken stone, begin rolling at the sides, and continue thus by running ahead, so as to allow from 2 to 5 inches of the driving wheel to pass over the shoulder, and backward with the outer edge of the driving wheel from 5 to 10 inches inside the edge of the broken stone. Roll until the stone ceases to "wave" in front of the wheels, and until it seems firm under foot as you walk over it. Next, begin on the other side, and roll in the same manner. Then work toward the center until the stone is rolled. Roll each layer of stone in the same manner.

If the road shows a wavy motion after passing the roller over it three, four, or more times, it may indicate too much moisture in the sub-grade. If, on examination, you find this to be true, stop rolling and move ahead, allowing the sub-grade to dry out. With some coarse, hard granite rocks it has been noted that after the roller passes over them a few times they begin to "crawl" and the sharp edges break off. A slight sprinkling of sand or stone screenings, or water may prevent this. Try one after another of these means until the work progresses to your satisfaction. You must not expect to prevent the stone from shaking as you walk over it, but you need to continue the rolling until the fragments of stone adjacent to where the foot presses do not move as you walk. Most of the rolling must be done before you spread the screenings. After spreading the screenings, water and roll until the mud flushes to the surface. You cannot expect to prevent the stones from kicking out if teams pass over the road. Keep watch, and in a few days have the roller pass once or twice over the road, after watering, until the loose stones are pressed down out of sight.

Before spreading any broken stone, great care must be taken to have the sub-grade carefully shaped and thoroughly compacted.

All shoulders must be shaped and left sufficiently high to roll to the proper grade before any broken stone is spread on the road.

In the case of heavy fills, you must not run the roller to the edge of the shoulders unless the fill has had time to settle. Work out slowly on this kind of work.

In every case, the screenings used on the surface as a binder course must be of the same material as the top course of the road.

Excepting where it may be needed to compact hard granite rocks, as above referred to, you will use water only on the top, or binder, course.

You will wet this binder course thoroughly before rolling, but not to the extent of saturating the foundation. You will get better results and prevent the screenings from being picked up by the wheels of the roller if you apply the water and allow it to settle down below the top surface before passing the roller over it. Too much water, or too little, will give trouble by causing the surface to be picked up.

You must not under any conditions roll the screenings when dry.

You must not under any conditions allow teams to pass over the road after the screenings are spread and before they are rolled.

In case of a deficiency in the water-supply, you may have the screenings spread and await a rain before rolling; but in such case the road must be entirely closed to travel, and the rolling must be begun as soon as the road is wet, and continue until the section covered with screenings is thoroughly compacted. In such cases, it may be necessary to operate the roller day and night, and you must insist on this being done.

GRAVEL ROADS.

Gravel, if properly laid and rolled, makes an excellent road, and, though it will not pack so closely at first as macadam, with proper care and attention to repairs it will ultimately become almost as solid as a stone road. It should be laid similarly to macadam, the larger pieces having been first separated from the smaller by screening; no piece should be used larger than 2 inches. The first course is formed of a layer of about 3 inches of gravel from 1 to 2 inches in diameter, thoroughly rolled and wet down; on this should be spread the second course, of gravel from 1 inch down, to a thickness of about 3 inches, and the whole thoroughly sprinkled and rolled. Avoid using large cobbles for this purpose; they will not pack, and will invariably in time work up to the surface.

THICKNESS OF LAYERS OF SURFACING MATERIAL.

As has already been pointed out, the surfacing of a road is merely to serve as a roof to protect the sub-grade, or foundation, from wear by passing traffic and from washing by rain. So long, therefore, as a practically impervious surfacing is laid, any increase in its depth is unnecessary, and is so much money buried in broken stones. As will be seen from the accompanying diagrams, the old Roman roads were of immense thickness as compared with our modern macadamized highways, being paved with large blocks on top, and underneath this lay a substratum of three layers, the first being of dirt, the second of small broken stones or gravel, and the lowest layer of larger-sized broken stone.

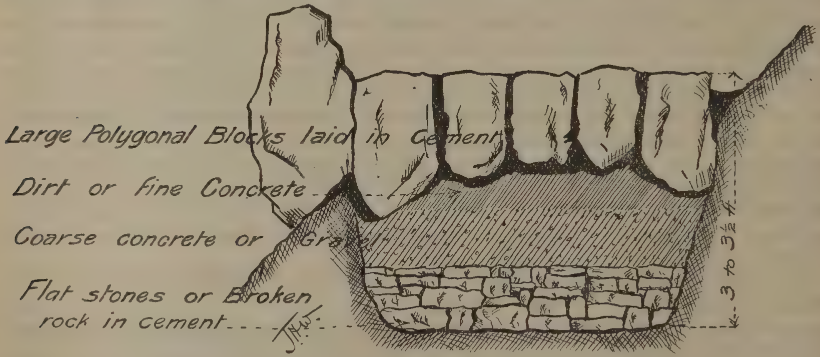

Large Polygonal Blocks laid in Cement
Dirt or fine Concrete
Coarse concrete or Gravel
Flat stones or Broken rock in cement
3 to 3½ ft.

FIG. 6. Section of Roman road.

The late eighteenth century road was very much reduced in thickness, the Telford principle of foundation of large flat stones set on end being used as a substratum, with broken metal placed on top.

The modern macadam road of about 6 inches in thickness has been found all-sufficient everywhere, and will withstand the heaviest traffic put upon it, if properly laid and cared for.

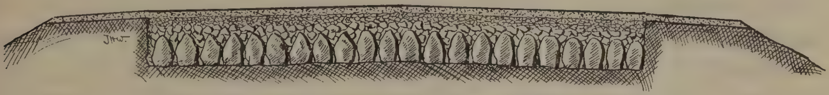


FIG. 7. German type of Telford road.

MAINTENANCE.

To no other industry can the old adage that "a stitch in time saves nine" be better applied than to road-building. The smallest hole or depression will soon become a large and expensive one to repair if neglected. If, on the appearance of depressions, a few shovelfuls of gravel or broken stone are deposited, the passing traffic will soon settle the material in place; but, with neglect, the hole or depression increases in size at an astonishing rate, as water will invariably collect there after rains, will soak into the road, soften the roadbed, and the horses' hoofs will do the rest.

A sure index to the weakest parts of a road is its condition after a heavy rain. Careful examination of those parts of the roadbed where the water collects should be made, with a view to draining the same, either by the placing of proper culverts or ditches or by leveling up the low spots.

ROAD-SPRINKLING.

As water, if not properly disposed of by a thorough system of drainage, is the great destroyer of roads, so is it, if properly applied by sprinkling, a great preserver. The wear of passing traffic is bound to disintegrate the surface of even the most thoroughly macadamized highway, and the wind will soon carry these particles away, cutting large trenches in the road, and exposing the substratum to ensuing rainstorms and further wear by passing vehicles. In many counties of the State road-sprinkling is receiving due attention, while in others, even where water can be easily procured from natural watercourses, or wells or ditches along the road, sprinkling is neglected, and the road allowed, literally, to blow away. Dusty roads are not only an exhibition of neglect, but are a source of extreme discomfort and inconvenience to travelers, and are a positive injury to orchards and grainfields lying adjacent to the road.

USE OF OIL ON ROADS.

It may be of interest to note that oil has been used for sprinkling, or surfacing purposes, with quite a degree of success, especially in Los Angeles and San Bernardino counties. It has been found, not only to prevent dust, but to form a water-proof covering for the roadbed. With the recent discovery and development of large oil-fields in this State, it is recommended that this work be continued in those sections where the expense will warrant it, as, if properly applied, the coating will last a considerable length of time, and the necessity of sprinkling with water will be done away with. In applying the oil, it must be thoroughly mixed with the dust. Mere sprinkling will not thoroughly impregnate the dust, but forms a cake on the surface, which adheres to the wheels of passing vehicles, and the road's "last state is worse than its first." The crude oil (preferably mixed with mineral pitch) should be spread on the road in furrows, and thoroughly incorporated with the dust by raking. The road should then be sprinkled with water and thoroughly rolled. Various mechanical devices for performing this work have attained quite a degree of perfection in the southern part of this State, and an examination of the roads treated with oil shows the process to be worthy of encouragement and further experiment.

The use of oil is also recommended in the construction of the subgrade or foundation of stone or gravel roads, where the substratum is of a soft or spongy nature, a thin layer of dry earth being spread over the oil-sprinkled surface, and well rolled before the road-metal or gravel is laid.

WIDE TIRES.

The matter of wide tires is receiving marked attention, not only in their use being advocated by promoters of good roads, but in their voluntary use by farmers and others engaged in teaming, even in localities where no regulations exist compelling their use. Wagon manufacturers in all sections of the country report a growing demand for wide tires every year, and, once used, the wide tire is never departed from. Were the people only to realize the immense benefit that would accrue to themselves by the use of broad tires, legislation would be unnecessary in this direction.

The wide tire is not only a road-maker and road-preserver, but a long series of experiments, carefully conducted over roads of all classes and in all conditions, have gone to show that the energy necessary to draw a given load on a wagon is greatly lessened where wide tires are used, and that a given energy will haul a largely increased load. Experiments have demonstrated that a given load on a 1½-inch tire drew about 40 per cent heavier than when on a 3-inch tire, the draught being on a fairly stiff grass sod. On a moist, but hard road, the 1½-inch tire drew from 12 to 15 per cent heavier than the 3-inch. (See "Wide Tire and Narrow Tire Tests," page 65.)

Ordinary farm wagons should be equipped with tires at least 3 inches wide; and it has been found successful in this respect to so lengthen the rear axle that the rear wheels will run about an inch outside of the front wheels, thus rolling a larger surface, and distributing the load more evenly over the road.

In many of the States, laws are in force regulating the width of tires, some of them compelling the use of a certain width of tire for a prescribed load, others allowing rebates in the way of tolls, taxes, etc., where tires are of a certain width. In almost all European countries, and especially in those where particular attention is given to the proper care of roads, the use of narrow tires is positively forbidden.

The following is a brief summary of some of the laws governing the width of tires in the various States and in foreign countries:

CALIFORNIA.

(Chapter 206, March 16, 1889, Sec. 25, Art. 39.) Boards of Supervisors in their respective counties have power to enforce regulations concerning size of wagon and width of tires.

MICHIGAN.

(Act approved June 8, 1883; amended May 12, 1897.) All persons who shall have used only lumber wagons with tires of not less than 3½ inches in width, for loads exceeding 800 pounds, shall receive a rebate of one fourth their assessed highway taxes, provided such rebate shall not exceed in any one year three days' road-tax for any person.

NEW YORK.

(Statutes of 1893, Chapter 468.) Every person who uses wagons carrying a load of 1,000 pounds, and with tires of not less than 3 inches in width, shall receive a rebate of one half of his assessed highway tax for each year, not exceeding, however, in any one year $4, or four days' labor.

By law of May 10, 1894, Chapter 686, laws of 1892, was amended by adding Article 79: In counties where the expenditure for road purposes exceeds the sum of $500,000, the Board of Supervisors may enact laws regulating the width of tires of vehicles built to carry a weight of 2,500 pounds or upward.

In Queen's County, N. Y., all vegetable wagons, weighing when loaded 2,500 pounds or more, shall have tires of not less than 3 inches in width.

OHIO.

(Act approved April 20, 1894.) It shall be unlawful for any person to transport over any road, in any vehicle having a tire of less than 3 inches in width, a burden of more than 2,000 pounds. County Commissioners are empowered to employ suitable persons to see to the enforcement of this law.

(Passed March 6, 1894.) In counties of a population, on the census of 1880, between 33,510 and 33,515 (this applies to Scioto County), the following regulations may be enforced by the County Commissioners: All vehicles carrying a load between 2,500 and 3,500 pounds must be provided with tires not less than 3 inches wide; those carrying a load between 3,500 and 4,000 pounds must have tires not less than 3½ inches in width; between 4,000 and 6,000 pounds, the minimum width is fixed at 4 inches; between 6,000 and 8,000 pounds, 5 inches; and over 8,000 pounds, 6 inches.

INDIANA.

Indiana has a law against hauling on a wet gravel road a load of over 2,000 pounds on a narrow-tired wagon, or over 2,500 pounds on a broad-tired wagon.

KENTUCKY.

On the toll-roads, the rate for a loaded narrow-tired wagon drawn by four horses is 40 cents; for a wagon with a 4-inch tread, under same conditions, 35 cents; narrow-tired wagons with five animals, 60 cents; wagons with 4-inch tread, 50 cents; narrow-tired wagons with six animals, 75 cents; wagons with 4-inch tread, 60 cents.

VERMONT.

R. R. Sec. 3135 prescribes a minimum width of tire of 3 inches for wagons loaded with burdens of between 3 and 4 tons, and if carrying more than 4 tons the tires must be at least 4 inches wide.

MASSACHUSETTS.

All vehicles are exempt from taxation, if furnished with tires proportioned to the weight of the wagon according to the following schedule: Wagons weighing not less than 1,000 pounds nor more than 1,500 pounds, to have tires not less than 3 inches in width; from 1,500 to 2,000 pounds, 3½-inch tires; 2,000 to 2,500 pounds, 4-inch tires; 2,500 to 3,000 pounds, 4½-inch tires; 3,000 pounds and over, 5-inch tires.

AUSTRIA.

In lower Austria, a width of wheel rim of 4½ inches is required for loaded wagons drawn by two or three horses, and in Bohemia the same regulation is in force. All wagons built for a load of more than 2¼ tons must have wheels with rims at least 4½ inches in width in Styria and Carinthia; and if built for more than 4½ tons (in Styria) or more than 3½ tons (in Carinthia), the rims of the wheels must be at least 6¼ inches wide.

FRANCE.

All freighting and market carts must have tires from 3 to 10 inches wide, usually from 4 to 6. (This applies to two-wheeled carts.) The 4-wheeled wagons very seldom have tires less than 6 inches wide, and the rear axle is usually longer than the fore, so that the hind wheels run about an inch outside of the level rolled by the fore wheel. (This plan is recommended elsewhere in this Report.)

GERMANY.

The Act of April 16, 1840, prescribes that wagons for heavy loads, such as coal, brick, earth, or stone, must have a width of tire of at least 4 inches, and shall have a flat and not a rounded surface. Light vehicles must have tires at least 2½ inches wide.

SWITZERLAND.

Wagons must be provided with wheels having tires of a width proportional to the largest load admissible. Two- or more horse wagons shall have a width of tire not less than 1 inch for each draught animal. Vehicles for transportation of heavy objects which cannot be taken apart must have tires not less than 6 inches wide.

CANADA.

In Ontario the width of tire shall not be less than 2½ inches for a load of from 500 to 1,000 pounds on each wheel. For loads of from 2,000 to 3,000 pounds to the wheel, each wheel shall have a width of not less than 6 inches.

ROAD STRUCTURES.

Road structures, ranging in size from the small cross-drains and culverts, to large bridges spanning streams, form an important and considerable item of expenditure in the construction and maintenance of a highway system.

The use of cement or vitrified clay pipe is strongly recommended for the construction of drains and culverts from 6 to 24 inches in size, and the old-style wooden boxes, which have to be continually replaced, necessitating the tearing up of the roadway, should be done away with. If vitrified pipe is used, care must be taken in laying it, a proper grade being given to the trench, that water may run through freely, and danger of clogging be averted. Sand has been found to be a most effective material for the bed of clay or cement pipe, as, when properly packed, it has absolutely no shrinkage or settling qualities. All joints should be carefully made of cement mortar, and, if possible, the pipe should be jacketed with concrete, to a thickness of from 2 to 4 inches. The accompanying sketch shows the best form for such a jacket. Dirt should then be gradually filled in and carefully tamped.

Where small natural watercourses are encountered, culverts should be constructed of stone, cement, or brick masonry. If this be found too expensive, however, and it is necessary to use wooden planking, the sides of the watercourses should be prevented from washing by the construction of walls of masonry (laid dry, if necessary), thus insuring a solid foundation for the planks to rest on.

Iron and steel bridges should receive careful attention, all metal-work being kept painted and free from rust, and, if floored with wood, should be protected with a coating of asphalt or other material.

Stone bridges are gradually coming into use in California, and are not only permanent, and inexpensive to maintain, but are very attractive in appearance. Their cost, while primarily comparatively high, compares most favorably with that of wooden and metal structures, as a good stone bridge will last for ages, and the cost of maintenance is practically *nil*, while other structures require constant expensive repairs and renewal, and, at the best, their life is but short.

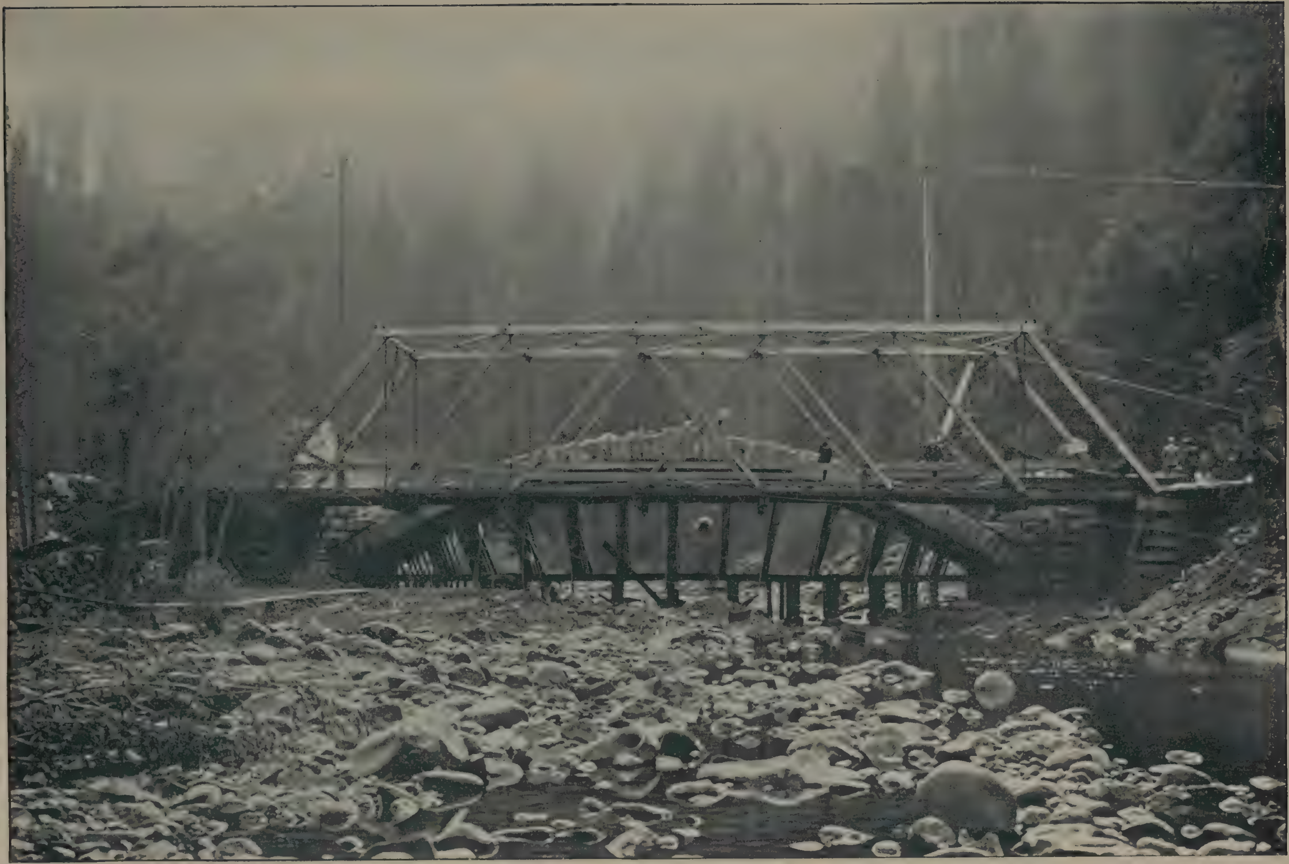
A large single-arch bridge of 81 feet span has just been completed by the Department on the Lake Tahoe State Wagon Road, crossing the American River near Riverton, El Dorado County. It replaces an old combination truss bridge, which is giving way and is unsafe for travel in its present condition. (The iron-work, which is in a fairly good state of preservation, will be used in the construction of a truss bridge at a less important point on the road.) The material used is a fine quality of granite, quarried near by.

Reference is made to the accompanying plates, showing the bridge in course of construction, and plans taken from the drawings accompanying the specifications.

MILESTONES AND SIGN-BOARDS.

The accompanying cut illustrates the milestones as set on the Lake Tahoe Wagon Road; they are about 18 inches wide, 6 inches thick, and 54 inches high, of which 18 inches are set in the ground. They are cut from granite, roughly hewn, a smooth face being dressed for the cutting of the legend and arrow, indicating mileage and direction to Placerville, the county seat and nearest railroad town.

Sign-boards should be placed at all intersections of roads with another, indicating the direction and distance to nearest towns or cities, and rigid laws should be enforced for their protection. The practice of shooting at them and otherwise defacing them, or of turning them around in such a manner as to deceive or confuse the traveler—this latter being thought by some people to be a "funny trick"—should be treated with severe punishment, as are other cases of wanton misuse and destruction of public property.



Construction of New Stone Bridge at Riverton, Lake Tahoe State Highway, Showing Old Combination Truss Bridge.

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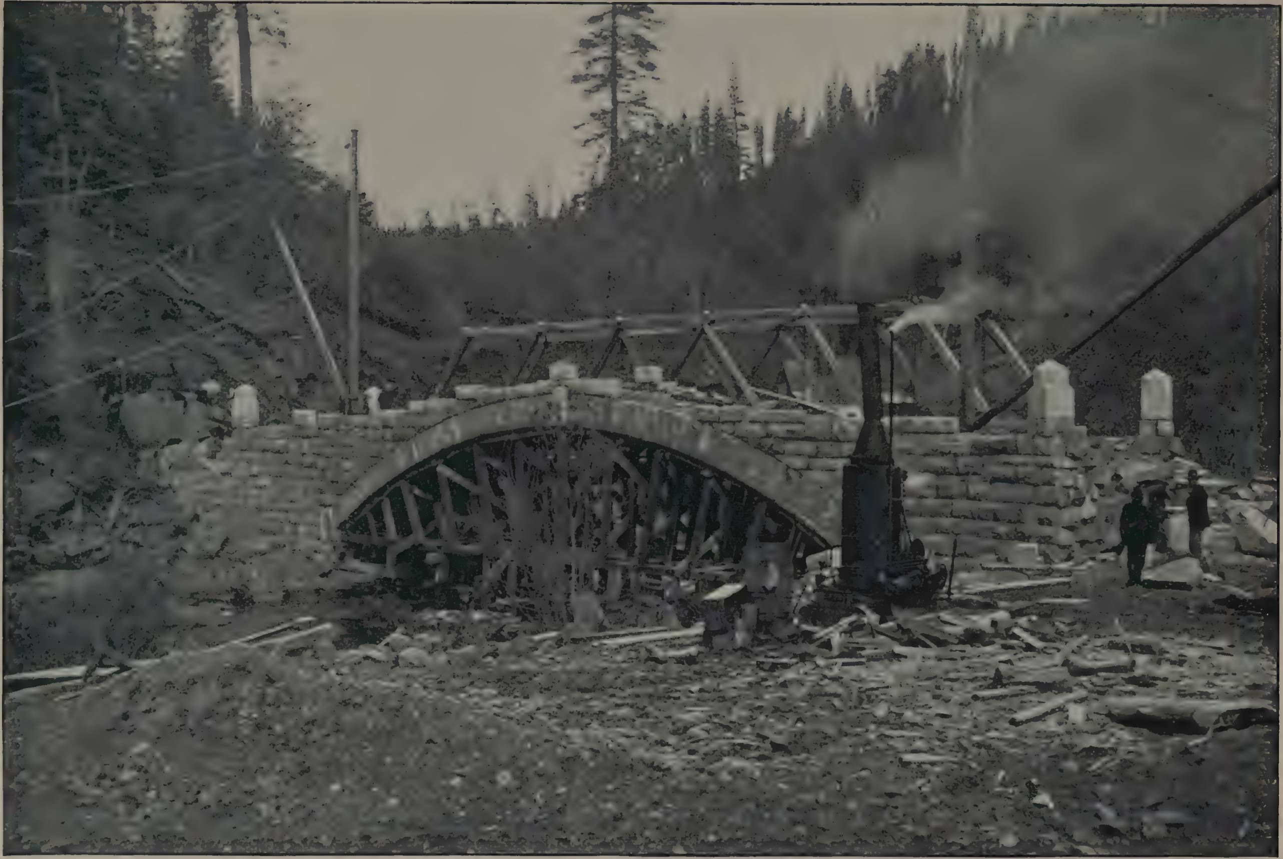
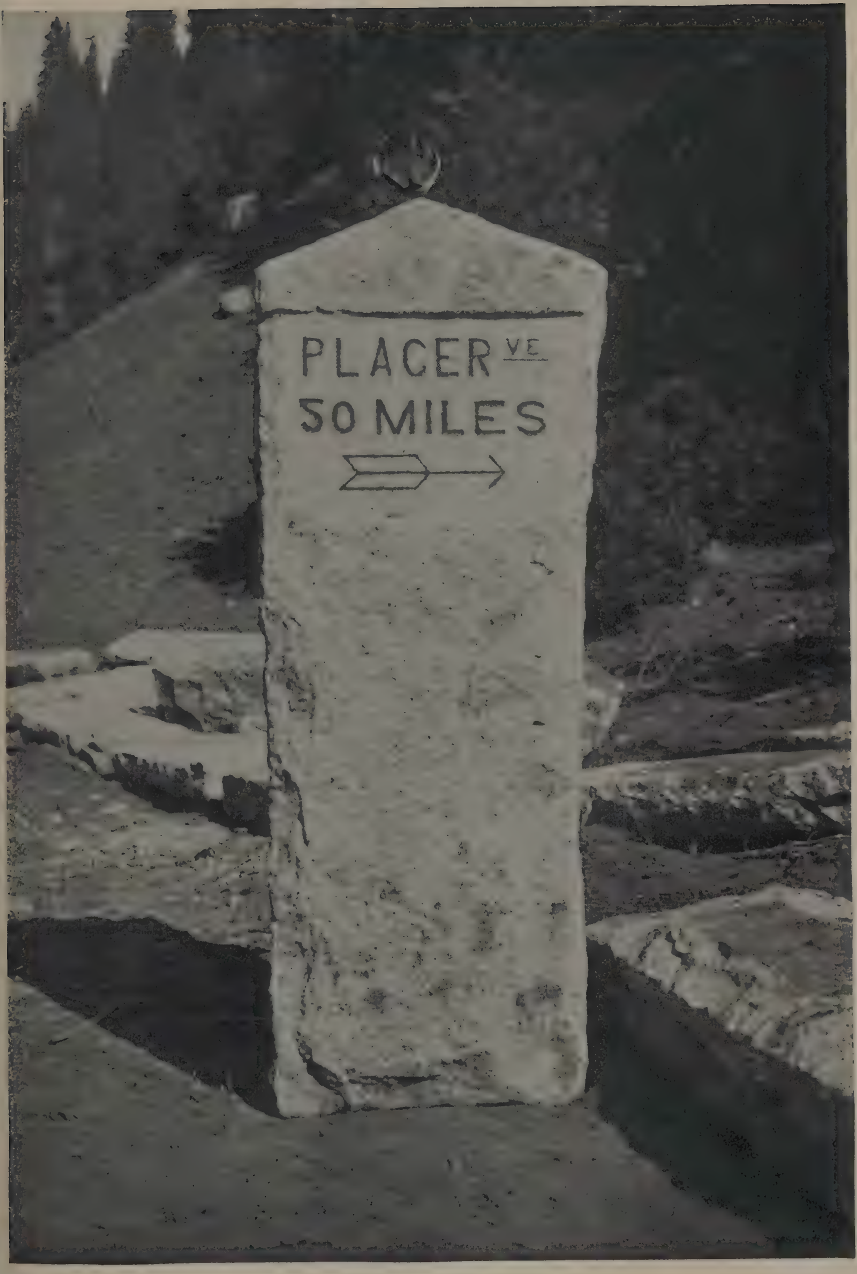


New Bridge (Course of Construction), Riverton, Lake Tahoe State Highway. Longest stone-arch span (81 ft.) on Pacific Coast.



Granite Milestone, as Erected on Lake Tahoe State Highway.

It would be well to have a portion of the County Road Fund set aside for the erection and maintenance of such monuments. Their absence and neglect are of too frequent occurrence in this State.

ROAD MACHINERY.

The success of any work depends upon the use of proper tools and machinery as much as it does upon the employment of skilled mechanics, artisans, and laborers; and, before good roads can be made, the community must be furnished with the proper implements. While many of the counties of the State are fairly well provided in this respect, others are so situated financially that the purchase of improved road machinery would be quite a burden. It is, therefore, recommended that State aid be furnished in this respect, by the purchase of improved road machinery, such as first-class graders, rollers, and portable rock-crushers, which may be loaned to the various counties where need for them is seen to exist.

GRADERS.

Road-plows, graders, and scrapers are of such universal use that passing notice only may be given them. They form an important factor, however, in the primary work of road construction, as, with proper manipulation, one machine, with the necessary complement of men and horses, will perform an amount of work equivalent to a very large body of men working with hand tools.

Judgment, however, must be exercised in their use, especially as to the season of the year when grading should be done.

In California, where the season of rainfall is usually well marked, it should not be a hard matter to fix the proper time for the grading of roads. Grading should be started, if possible, immediately prior to the first rain-storm of the season; but too often do we see the destruction of a fairly good piece of road by unseasonable grading. The local road overseer will delay until spring, by which time the heaviest rains have usually fallen, and will then start on his work of grading, leaving the road to be settled by the late rains, which are generally insufficient, and, by summer time, the road is covered with a thick coating of dust. By starting the grading of a road early in the rainy season, the benefit of the settling effect of all the rainfall is received and the road can be thoroughly worked and rolled when it is moist.

The principal work performed by the grader is the crowning of the road and the digging of side ditches. These matters have already been treated of.

ROLLERS.

The importance of the proper rolling of roads has been already dwelt upon. If the roller is not used, the surfacing material is in a continual state of disturbance; the angles are worn round, and compact consolidation becomes impossible.

One of the most important auxiliaries to road-making was the introduction of the steam-roller by M. Polonceau in 1834. The use of rollers weighing more than 12 tons is being discontinued, as the ordinary 12-ton roller may be loaded to 15 tons, and a weight in excess of this has a tendency to crush rather than to consolidate the road-metal. Very few bridges in this State can stand the weight of a 20-ton roller.

Horse-rollers, weighing from 2 to 6 tons, are very serviceable, and much good work can be performed by them on ordinary dirt roads, or those having slight surfacing only, where a heavy steam-roller is unnecessarily expensive.

ROCK-CRUSHERS.

Portable rock-crushers are very convenient in utilizing material that happens to lie along the road or in the vicinity, and especially would they prove serviceable in California, where good road-building material is so abundant. They can be used as the work progresses, so that the source of supply may never be any considerable distance from the road under construction.

Various forms of portable rock-crushers are manufactured, of a capacity of from 75 to 300 tons per day; they require a steam-engine of from 5 to 10 horse-power to run them. 100 tons of crushed rock is sufficient for the laying of 2,500 square feet of macadam, 6 inches thick, when packed and rolled solid.

ROAD RECORDS AND MAPS.

It is as essential that every county should have a complete record of its roads that it is that a railroad company should have maps and records of its rights of way; and in those counties where deeds do not exist or cannot be found, conveying rights of way for roads that are in use (and there are many such instances), steps should be taken to secure the necessary quitclaims, so that future litigation may be prevented, and that the county may have power to resist encroachments on its rights of way.

A thorough map system, in sheets on a scale of, say, four inches to the mile, covering each county, should be prepared, showing, by conventional signs, the direction of the road, its length between various courses, width, material composed of, nature and ownership of adjoining property, locations of water and road-building material, locations of milestones, sign-boards, bridges, culverts, railroads, waterways, etc., and sufficient contour lines should be drawn to indicate the watershed of the road. A system could easily be devised whereby these features could be indexed, reference being made to fuller descriptions contained in deed-books, records of culverts and bridges, etc.

In laying out the tracing of a road, preliminary to actual survey, the United States Geological Survey charts are very useful in such localities as have been covered by this survey.

PHASES OF THE ROAD QUESTION.

CONVICT LABOR.

Condemnation to labor on the public roads was a form of punishment for misdemeanor in many of the Eastern States during the eighteenth century, but it was abandoned early in the present century, and not taken up again until in recent years. The system of working convicts on the roads has been found successful in some of our States—notably in North Carolina, Georgia, Tennessee, and Kentucky.

It is argued by some that their employment is in direct competition with free labor, though those States that have adopted measures for convict employment claim that exactly the reverse is the case; that this is the only manner in which convicts may be employed in which their work does not come in direct competition with free labor, and that it is certainly more advantageous for the community to have the roads improved by those for whose support they pay taxes than to have to pay taxes both for the improvement of the roads and for the support of the convicts also.

In this connection it is interesting to note the conditions existing in other States:

In North Carolina the law of March 7, 1887, provided that when any county has made provision for the working of convicts on its county roads, the Judge holding court in such county may sentence to imprisonment and hard labor on the roads the following classes of convicts: First, all persons convicted of offenses the punishment whereof would otherwise be wholly or in part imprisonment in the common jail; second, all persons convicted of crimes, the punishment whereof would otherwise wholly or in part be imprisonment in the penitentiary for a term not exceeding ten years. In such counties there may also be worked upon the public roads all persons sentenced to imprisonment in jail by any magistrate, and also insolvents who may be imprisoned for non-payment of costs in criminal cases, a rate of compensation to be fixed for the work of the last-named class. Provided that no person who has been convicted of and sentenced on a charge of murder, manslaughter, rape, or arson shall be assigned under this law. Each county is charged with the keeping and proper custody of the convicts while at work, and must pay all expenses of transportation to and from the penitentiary.

Another law, similar in its effects and provisions, was ratified by North Carolina, March 11, 1889.

From information gathered by Professor J. A. Holmes, State Geologist for North Carolina and Secretary of the State Road Association in 1895, it appears that the General Assemblies of the State, in the years 1867, 1873, 1875, 1877, 1879, and 1889, have made provisions for the use of convicts upon the roads in case any county should desire it; and their employment has been an important factor in inducing counties to vote a tax for the improvement of roads. Statistics gathered from eighty counties in the State show that the average cost of the maintenance of a convict, while confined in the county jail, is about 30 cents per day; while returns from a number of counties employing this class of labor show that the cost of maintenance is reduced to a general average of about 24 cents while they are at work on the public highways.

In all cases, the convicts are carefully described and photographed; they are offered certain inducements in the way of awards and shortening of terms for the faithful discharge of their duties, and are allowed to visit their homes from Saturday night until Monday morning.

The general result has been that but few convicts have attempted to escape; that their health has been improved; that the cost of their maintenance has been lessened, and that their labor, under skillful supervision, has proved much more efficient than that which can be hired by the prevailing rates.

The Road Law of Delaware (Chapter 670, 1893) provides for the purchase by the Levy Court of New Castle County of a stone quarry producing material suitable for macadam, and for the employment therein of persons convicted of such crimes as obtaining money under false pretenses, carrying concealed weapons, gambling, lottery, assault and battery, disorderly conduct, vagrancy, etc. The law further provides for an equitable distribution of the quarry product.

Along this line, viz: the employment of convicts in the preparation of road material, the following other States have enacted laws: Iowa, New York, New Jersey, and California.

It will be noted that in the Southern States only prisoners convicted of the lighter class of crimes, or "short term" prisoners, are worked publicly, and it should be remembered that, as a rule, the inmates of the Southern penal institutions are of a different character to those in this State. The convict lease system is still prevalent in many of the Southern States, and, in the words of General Roy Stone, Special Agent and Engineer, Office of Road Inquiry, U. S. Department of Agriculture, "in Southern States, where the convict lease system, with all its objectionable features, still prevails, it is clear that a transfer of prisoners from irresponsible and often inhumane private employ to the care of States or counties would be a saving kindness to them, while it would wipe out a public disgrace and benefit the entire community."

*When the proposition of working convicts on the public highways of New York came before the Prison Association of that State, it was emphatically denounced by such well-known penologists as Edward B. Merrill, James McKeen, Lispenard Stewart, Felix Adler, John R. Thomas, Benjamin Ogden Chisholm, and Frederick G. Lee, in that:

1. Such employment of convicts would as seriously interfere with labor outside the prisons as any other form of convict labor.

2. The State convicts could only be employed on State roads, unless there was a violation of the law which prohibits the employment of convicts under contracts. If the counties employed them, they would be obliged to make a contract with the State for them.

3. A very large body of keepers would be required to prevent escapes; escapes would frequently occur, and there would be a constant necessity for shooting convicts in order to prevent their getting away. There would soon be a death-rate among our convict population approaching that known to have existed among the convicts of the South who are employed on public works.

4. In many cases the prejudice against convict labor would require a military force to protect the convicts who are at work.

5. (*a*) It has been found a hardening and demoralizing process to the convicts themselves to employ them in public places; (*b*) and it has been found by penologists to be a demoralizing process to the public at large to see this daily spectacle of shame.

It is the opinion of the Department that, so far as California is concerned, the most feasible solution of the question has already been reached in this State, by the employment of convicts in turning out crushed rock for highways, and in quarrying and cutting stone for highway structures and other public improvements, within the walls of the penitentiary. For about five years quarries of trap-rock and granite have been worked, and a large stone-crushing plant has been operated, at Folsom State Prison, and the product distributed throughout the State, public works having the preference, while the surplus, if any, may be sold to any one applying for it. In this way the convicts are engaged in turning out a product the use of which encourages public improvement and causes a demand for free labor; natural sources of fine stone are made use of which could not be made available in any other manner, and the prisoners require no extra guard, and are screened from public view, being employed within the walls of the State Prison.

The Department does not advocate the employment of convict labor in California in any other manner than that now in vogue.

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*Bulletin 16, U. S. Department of Agriculture, Office of Road Inquiry.

TRACTION TESTS.

A most interesting series of experiments in traction was made by the United States Department of Agriculture at the Cotton States and International Exposition in Atlanta, Ga., in 1895 (at which your Commissioner was present, as the representative of the California Bureau of Highways).

The tests were made over three styles of roads—a macadam road, a sand road, and an ordinary dirt road. The macadam road was 300 feet in length, made up of six 50-foot stretches, the first one level, and the other stretches rising to 2, 4, 6, 8, 10 per cent grades. It was constructed of broken stone, 6 inches deep and rolled by a 15-ton steam-roller. The other roads were 200 feet long, with 50-foot stretches, the first level, and the succeeding ones rising 2 feet, 4 feet, and 6 feet in the hundred, respectively. The sand road was constructed of 6 inches of river sand, laid on a natural clay bed, neither the bed nor the surface being rolled; while the dirt road was made by the grading up of natural earth. This was thoroughly wet, and deep ruts formed on it by passing a heavily loaded narrow-tired wagon over it a number of times, the object being to make the last two mentioned roads conform as nearly as possible with the average sand and muddy roads, respectively, prevalent throughout the State.

A heavy farm wagon, loaded with cotton bales, each weighing about 500 pounds, was drawn successively over the various forms of road, and the amount of pull indicated by a machine known as the "tractometer."

The following is given as a result of the experiments:

On the smoothest possible macadam road surface, the force of traction was not constant, but changed continuously within a range of 50 pounds.

On the ordinary dirt road, the force varied from absolute zero to 700 pounds (in a gross load of 3,000 pounds), becoming in effect a rapid succession of violent jerks.

On heavy grades, in the case of the smooth road, the force was more nearly constant.

The force necessary to start a load on the smooth road was four times as great as the force required to draw the load at a uniformly slow pace when started, and was one tenth the gross load.

The force required to start a load on the dirt road was about one fourth the gross load, or not greatly in excess of the upper limit of the tractive force when the wagon was in motion.

From these observations the following conclusions are drawn:

A team harnessed in the ordinary way is subjected to a continuous jerking motion, which, on even the smoothest country road, is enough to greatly increase the fatigue.

On a dirt road in bad condition this jerking motion becomes a succession of heavy blows transmitted to the animal by means of the collar. The fatiguing effect of these blows is probably double that of a steady pull equal to the maximum figure reached in the oscillations, and, furthermore, they bruise the shoulders of the team, thus lessening its value, besides being cruelly painful.

Starting a heavy load is also equivalent to a heavy blow, as the driver ordinarily holds his team well back, and then urges it suddenly forward against the collar held by rigid traces.

The smoother the road, the more nearly constant will be the force of traction, and the less will be the fatigue of the team while doing the same amount of work; that is, if a load four times as great can be drawn over a smooth road as over a rough one, by exerting the same amount of force, then a team can haul four times as much in the same time over the smooth road and suffer much less fatigue in the same operation.

Some method should be adopted of making a more elastic connection between the wagon and the team, thus transmitting the shocks at the wheel rims as a gradual change of force to the team.

During these experiments, a team of small mules readily drew twelve bales of cotton (6,000 pounds) on a heavy Studebaker wagon up the 10 per cent grade of the macadam road, the tractometer indicating a pull of 1,000 pounds. The same team was stalled completely in going down the 6 per cent grade of the sand road, after pulling the indicator to 1,900 pounds. Nine bales of cotton were removed before the load could be again got in motion. The driver refused to venture at all upon the dirt road with the twelve-bale load.

On summing up the records, it was found that about four times as much force was required to draw one ton over the level stretch of the mud road as over the level stretch of the macadam.

WIDE-TIRE AND NARROW-TIRE TESTS.

A number of experiments in this direction were also made at the Atlanta Exposition, and it was found that on a wet clay road twice as much pull was exerted to draw a loaded wagon over part of the road which had been cut up by a heavily-loaded narrow-tired wagon as was necessary to draw the same load over part of the road which had been previously traversed a number of times by a wagon with 5- and 6-inch tires.

The following is a brief summary of the tests made with wide and narrow tires by the Missouri Agricultural Experiment Station; the net load in each trial being 2,000 pounds, and the tires 1½ and 6 inches wide:

1. On macadam street, a load of 2,518 pounds can be hauled on wide tires with the same draught that is required for a load of 2,000 pounds on narrow tires.

2. Gravel road. Except where wet and muddy on top, the draught on wide-tired wagons is very much less than that on narrow-tired wagons. Average: 2,482 pounds could be hauled on wide tires with the same draught required for a 2,000-pound load on narrow tires.

3. Dirt roads. (*a*) When dry, hard, and free from ruts, the weight hauled on wide tires was 2,530 pounds, as against 2,000 pounds on narrow tires with the same draught. (*b*) With a depth of from 2 to 3 inches of dust, the test was unfavorable to broad tires. (*c*) On clay road, muddy and sticky on the surface, but firm underneath, the result was also unfavorable to the wide tires. (*d*) On clay road, with mud deep and drying on top, or dry on top and spongy underneath, 3,200 pounds could be hauled on wide tires with the same draught as was required to draw 2,000 pounds on narrow tires. (*e*) On clay road, surface dry, but with deep ruts formed by narrow tires, the first test with wide tires showed an excessive draught over that of narrow tires running in their own ruts, but succeeding tests with the broad tires, which gradually eliminated the ruts caused by the narrow tires, showed a lighter draught than that required for the narrow tires, and demonstrated the effectiveness of wide tires as road-makers and road-preservers.

4. A large number of tests on meadow, pasture, stubble land, and plowed ground in every condition, from dry, hard, and firm to very wet and soft, show without a single exception a large difference (from 17 to 120 per cent) in favor of the broad tires. (See article on "Wide Tires," page 54, of this Report.)

TABLES OF GRADES, ETC.

The following tables, already referred to under the head of "Grades" (page 43), are taken from Byrne's Highway Construction. Table No. 1 shows a comparison of the loads that may be hauled over various grades and surfaces, taking 1.00 as unit of load; while the second table shows the equivalent number of miles of level road that a given load may be hauled over with the same amount of draught that is required to move it over various grades:

TABLE No. 1.

Table Showing the Relation Between Load, Grade, and Surface.

Grade.	Earth.	Broken Stone.	Stone Blocks.	Asphalt.
Level	1.00	1.00	1.00	1.00
1:100	.80	.66	.72	.41
2:100	.66	.50	.55	.25
3:100	.55	.40	.44	.18
4:100	.47	.33	.36	.13
5:100	.41	.29	.30	.10
10:100	.26	.16	.14	.04
15:100	.10	.05	.07	--------
20:100	.04	---- ----	.03	--------

TABLE No. 2.

Table Showing the Relation Between Length of Haul and Grade.

Rate of Grade per 100 ft.	Equivalent Length of Level Road.	Rate of Grade per 100 ft.	Equivalent Length of Level Road.
	Miles.		*Miles.*
0.0	1.000	2.50	2.244
0.25	1.121	2.75	2.363
0.50	1.242	3.00	2.484
0.75	1.373	4.00	2.982
1.00	1.500	5.00	3.444
1.25	1.622	6.00	3.986
1.50	1.746	7.00	4.844
1.75	1.871	8.00	4.982
2.00	2.000	9.00	5.480
2.25	2.120	10.00	5.977

TRAFFIC ON COUNTRY ROADS.

The following figures are taken from data collected and published by the United States Department of Agriculture:

1. Average length of haul from farms to market or shipping points: Eastern States, 5.9 miles; Northern States, 6.9 miles; Middle States, 8.8 miles; Cotton States, 12.6 miles; Prairie States, 8.8 miles; Pacific Coast and Mountain States, 23.3 miles; in the whole United States, average 12.1 miles.

2. Average cost per ton of 2,000 pounds per mile: Eastern States, 32 cents; Northern States, 27 cents; Middle-Southern States, 31 cents; Cotton States, 25 cents; Prairie States, 22 cents; Pacific Coast and Mountain States, 22 cents; whole United States, average 25 cents.

Average total cost per ton for whole length of haul: Eastern States, \$1.89; Northern States, \$1.86; Middle-Southern States, \$2.72; Cotton States, \$3.05; Prairie States, \$1.94; Pacific Coast and Mountain States, \$5.12; whole United States, average \$3.02.

It will be seen from the above figures that the length of haul in the Pacific Coast and Mountain States is far in excess of that in other portions of the United States, being almost double the average haul, while the cost is just a little below the average, making the average total cost per ton for whole length of haul two thirds more than the general average; and it is the opinion of the Department that, so far as these figures apply to California, it is an extremely conservative estimate.

What portion of the total cost of haulage is chargeable to bad roads can be deduced to a certain extent from the following information furnished by our Consuls in foreign countries:

In Belgium, in the provinces of Brabant, Hainaut, and Namur, the average cost is given at 9⅝ cents per ton per mile, while a leading agriculturist in Belgium furnishes the following figures: One horse can haul 1,000 kilograms (2,204 pounds) over and above the weight of the wagon or cart, 15½ miles, and return with a load in one day. The keep of the horse amounts to 4 francs ($0.772) per day, and the wage of the driver varies, according to locality and season, from 3 francs to 5 francs ($0.57 to $0.965) per day. For the purpose of comparison, applying prevailing rates in California (viz: keep of horse, 40 cents, wages of driver, $1.75 per day, a total of $2.15) we find that 2,204 pounds can be hauled 31 miles in one day, or at a rate a little over 6 cents per ton per mile (figuring 2,000 pounds to the ton).

In England, the cost of hauling to market is from 8 to 12 cents per mile per ton, the average two-horse load being 4,480 pounds.

In France, it is not unusual to find one horse hauling over two tons, and the cost is figured on the basis of one horse hauling 2,000 kilograms (4,408 pounds) 20 kilometres (12½ miles) a day, returning unloaded. Again, applying the rate of $2.15 per day ($1.75 for driver and 40 cents for horse), the result is that one ton of 2,000 pounds can be hauled one mile in France for 7.8 cents, applying California rates of pay of man and keep of horse. This increases to 12 cents when the haul is materially lessened.

In Germany, in the consular district of Frankfort-on-the-Main, a fair average for all seasons is 16 cents per ton per mile for a distance of 5 miles or less, from which figure the rate declines proportionately to 10 cents per ton per mile for a haul of 12 miles.

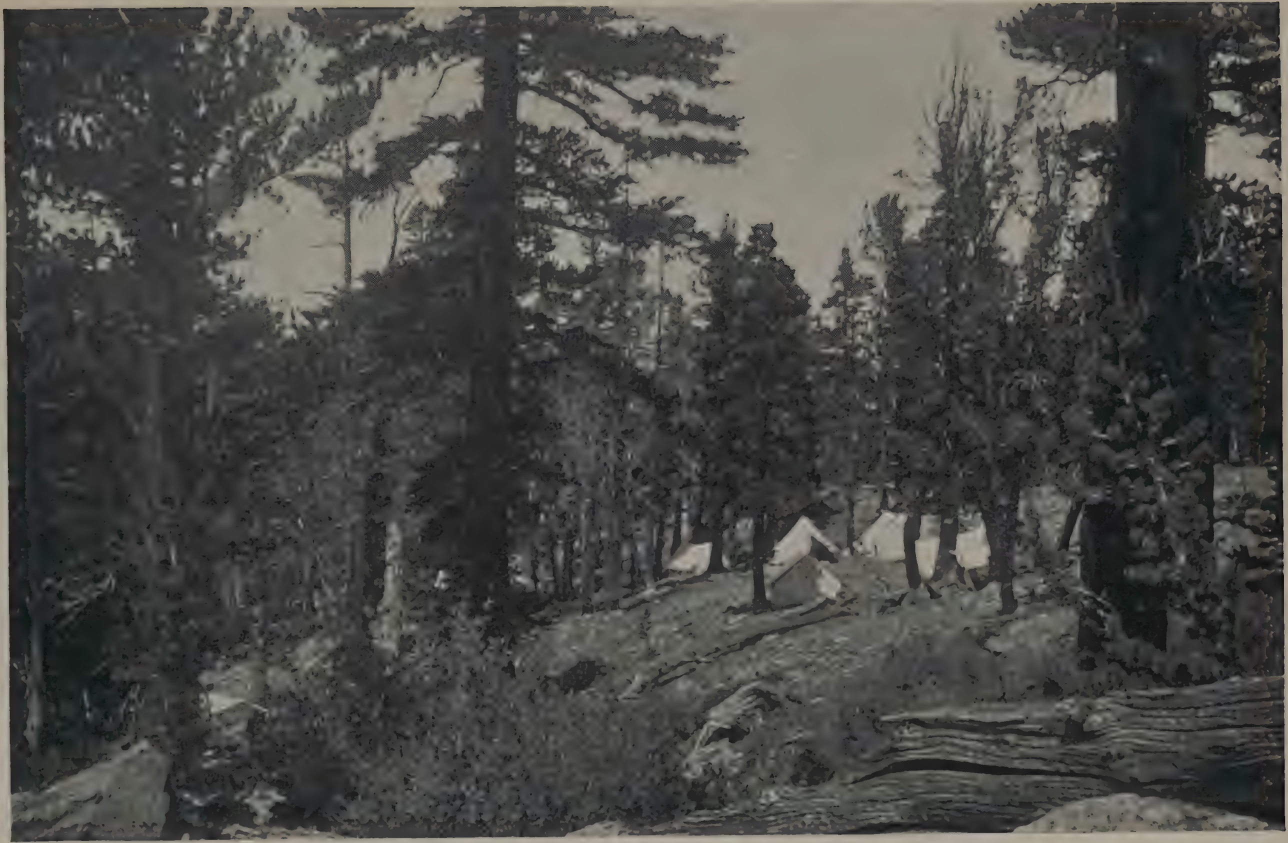
The following figures apply to Hanover (Germany): Haul of 6 tons for two horses, average distance 10 miles per day. Figuring cost of keep of two horses at 80 cents, and pay of driver at $1.75 per day, we find that 6 tons can be hauled 10 miles for $2.55, or at a rate of 4¼ cents per ton per mile.

In Brunswick (Germany), the average cost is given at 11 cents per ton per mile; in Plauen, 13½ to 15 cents; in Mannheim, 12 cents; and in Munich at 5 to 7 cents per ton per mile; (average load in Munich, 11,000 pounds for two horses).

In Switzerland, the average one-horse wagon is constructed to carry 4,400 pounds, and a two-horse wagon 8,800 pounds. The average draught-horse travels 24 to 28 miles a day on the Swiss roads, with a load of 12½ quintals (2,755 pounds). Figuring this on the basis of $2.15 per day (California rates, as given above), the average cost per ton per mile is found to be 6 cents.

The increase in cost of haulage and the decrease in weight which can be hauled by a given number of draught animals are by no means the only losses by bad roads. The loss of perishable products for want of access to market, the failure to reach market when prices are good, and the failure to cultivate products which would be marketable if markets were always accessible add many millions to the actual tax of bad roads.

Extension of Tioga Road—Character of Country over which Line Runs.



Camp C. F. Curry, Tioga Survey. Elevation, 10,318 Feet.

WORK OF THE DEPARTMENT.

Assuming office on the 25th day of May, 1899, there were found two appropriations in the State for road construction: One for the extension of the Tioga Road to the Mono Lake Basin, and the other for the Lake Tahoe State Wagon Road. Neither appropriation was, however, immediately available.

TIOGA ROAD.

Your Commissioner was also, ex officio, a member of the Yosemite National Park Commission, being associated on this commission with Colonel Samuel M. Mansfield, Corps of Engineers, and Captain Harry C. Benson, Fourth Cavalry, U. S. Army. Proceeding to Wawona, California, your Commissioner joined his conferees, and, during the months of July, August, September, and October, made thorough examinations of the roads leading to and through the Yosemite National Park and the Yosemite Valley, and more particularly of the three proposed routes for the extension of the Tioga Road to the Mono Lake Basin, the Tioga Road lying within the National Park.

These routes are known as the Levining Creek route, the Mill Creek route, and the Bloody Cañon route. The report of said commission is submitted herewith, as of special interest to the State of California.

Much interest has been displayed by various parties living to the east of the Sierras in the three various routes for the extension of the Tioga Road. The Mill Creek route, as may be seen from the report of the National Park Commission, was too expensive; the Levining Creek route, while possibly less expensive, is so situated as to be filled with snow earlier in the fall and later in the spring than the Bloody Cañon route; and the Bloody Cañon route also gives a shorter line for travel from the Mono Lake Basin to the San Joaquin Valley than any other route, and one which can be traveled for a much longer period of the year on account of its freedom from snow.

During the past summer an engineering corps was taken into the field, which carefully surveyed the Bloody Cañon route for an absolute location of the proposed roadway, a detailed account of which follows:

The field party assembled at Sacramento City, June 6, 1900, and proceeded by railroad to Hawthorne, Nevada; thence by team to Farrington's ranch, Mono County, California, where it was met by your Commissioner June 9th, and field camp was immediately established. The party was organized as follows: One chief of party, one levelman, two chainmen, one rodman, one back flagman, two axmen, and one cook. Work was begun June 13th, at Farrington's ranch-house, situated in the northwest corner of Section 34, Township 1 north, Range 26 east, Mount Diablo base and meridian, and a survey line through Bloody Cañon and over what is known as Mono Pass was run, until August 25th, when the survey closed, at a point on the Tioga Road, west of Dana Creek Fork, at the foot of Mount Gibbs, and west of the junction of Mono Pass trail with the Tioga Road, Tuolumne County, California.

A complete topographical survey of the line was made from Farrington's ranch to the Tioga Road. All natural features, such as creeks, lakes, streams, etc., were located, also limits of wooded and cultivated areas, and all houses, fences, trails, and roads.

The line was also cross-sectioned, and every point located from which to prepare an accurate topographical map, drawn to five-foot contours. A line of levels was run from the base, or bench, marks established by the United States Geological Survey.

In selecting this line, it was considered the most feasible and practicable route for an outlet for the inhabitants of that part of the country who are now virtually cut off from communication and from the markets of the State.

From Farrington's ranch-house the line runs through a varied and picturesque country for a distance of 17 miles, where it connects with the Tioga Road. Out of these 17 miles 4.73 miles are either broken or solid rock, the remaining 12.27 miles being of a character easily worked, and presenting no difficulties in the construction of the contemplated highway.

The line also runs on that side of the mountain most exposed to the sun, which would free it from the winter snows, and open it to through travel earlier than any other pass. One cannot commend this route too highly. In opening this road the State would be benefited by having a leading artery, connecting a large, fertile portion of the country, which is now entirely cut off from communication by the difficult and sudden rise, to surmount the almost impassable barrier of the eastern slope of the Sierra Nevada Mountains.

The trail, which now crosses the summit of Mono Pass, and is used occasionally, rises 2,770 feet in a distance of 2½ miles, which is equivalent to a grade of 1 vertical foot to every 4.76 feet horizontal; but in places, the trail rises 300 feet perpendicularly to 100 feet horizontally.

To convey a better idea of this deep and dangerous pass—dangerous mostly on account of the rock, which is hard, small and loose, making it extremely difficult for animals to retain their footing—photographs were taken, forming part of the survey record, some of which are reproduced herewith.

On this surveyed line, and as shown in the drawings in the office of the

On the Mono Pass Trail, Line of Extension of Tioga Road.

Department of Highways, the grade would not generally exceed 5 per cent, or a rise of 264 feet per mile. To obtain this grade, it was necessary to get distance to surmount the summit of the Pass. This was accomplished by carrying the line along the east side of Mount Parker, through pine timber and over mountain soil. The line continues through this character of country until the solid rock above the timber belt is reached, at an elevation of 9,226 feet. From here to the summit, a distance of 2.67 miles, the proposed route traverses a country abounding in either large broken, or solid, rock, and represents the only part of the line expensive to construct. From the summit to the connection with the Tioga Road, the country traversed is gently rolling, rich in pasture and spruce timber.

TENAIYA CANON ROAD.

In connection with the Bloody Cañon route, your Commissioner desires to call attention to the advisability of the construction of a road from Lake Tenaiya to the Yosemite Valley. It might be thought at first glance that this is a "tourist" route; but such is not the case. By the construction of the road through Bloody Cañon, the Tioga Road is tapped at what is known as the Dana Meadows. Thence following the Tioga Road, Lake Tenaiya is reached at a distance of about 15 miles. From Lake Tenaiya, the Tioga Road passes over the shoulder of Mount Hoffman, and thence by a circuitous route to Hodgden's, where the Big Oak Flat Road is joined. In this distance, many heavy grades are encountered and high altitudes reached, which, lying, as they do, in the very heart of the Sierras, are covered with snow a large portion of the year. All of this can be avoided by the construction of a roadway through the Tenaiya Cañon, which would pass by easy grades to the floor of the Yosemite Valley, avoiding snow, and saving a distance in travel of 50 miles, thus making a short route from the east to the west of California.

A large portion of this road lies wholly within the limits of the Yosemite Valley, where only the State can construct roads. If the roadway is ever constructed, it must be a charge upon the State. Not only will this roadway open a short route from the east to the west, but it will also open up to the people of California a most magnificent scenic section within the State, excelled in no other part of the world. The Lyell and Dana glaciers, equal to those of Switzerland, will then be within easy access of the tourist, while the high mountains, with their rugged peaks, with their forests, meadows, and waterfalls, will be accessible to all.

LAKE TAHOE STATE WAGON ROAD.

Attention is invited to the report of Commissioner Marco Varozza, hereto attached, for a detailed description of the work of maintenance of this road, which was carried on under the direction of and inspected by the Department.

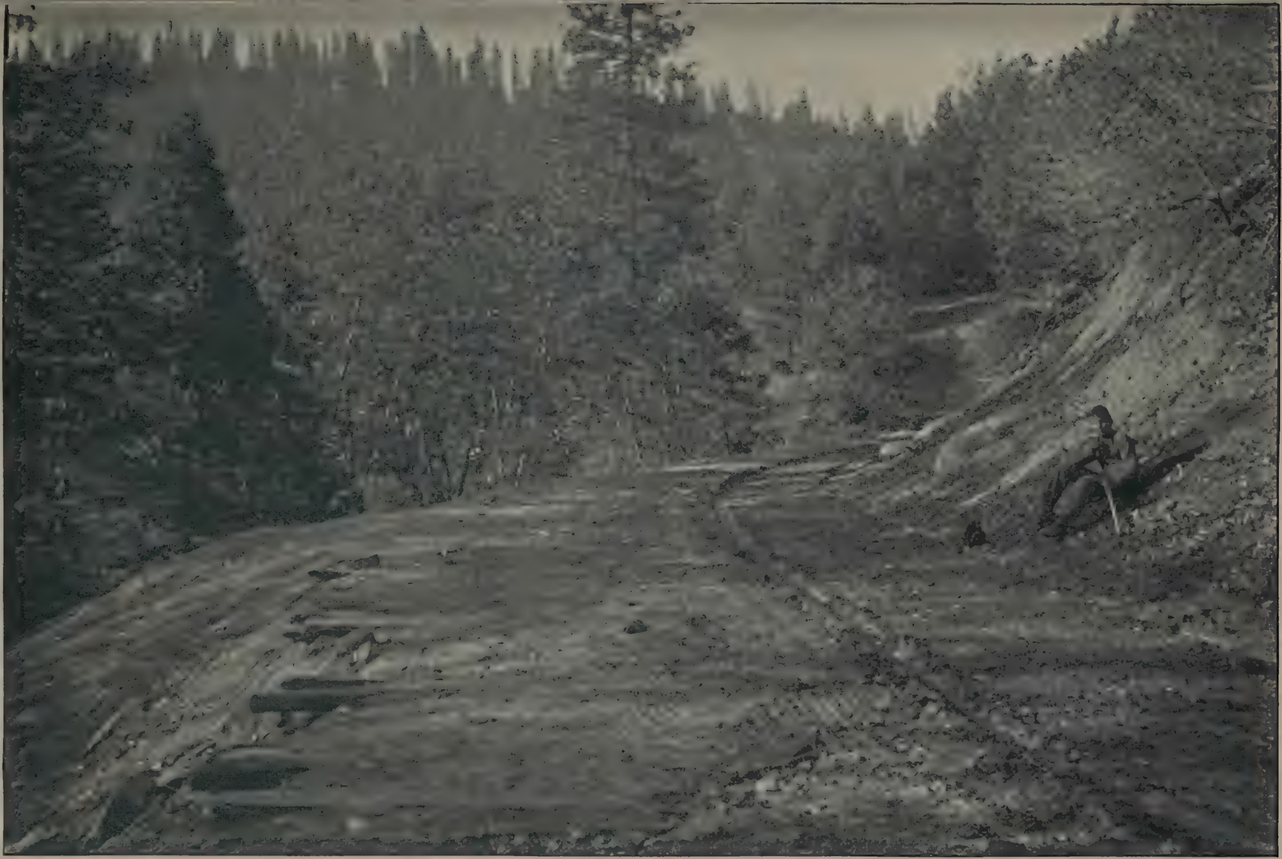
In addition to the maintenance fund of $8,000, there was appropriated by the Legislature of 1899 the sum of $25,000 for the construction of permanent bridges and culverts along this highway. The most important feature of this work has been the construction of a large stone bridge over the North Fork of the American River, at Riverton, replacing an old iron and wood truss bridge, now almost gone to decay. Detailed description and plans of this bridge appear elsewhere in this report. Retaining walls and smaller bridges have also been constructed along the road, at points where the same have been found necessary, and a large number of clay-pipe culverts have been placed. There is an abundance of excellent material lying along this road, in the way of trap-rock, granite, etc., and by the use of this material, crushed by a portable rock-crusher (should the State purchase one), the facilities for the construction of an excellent road cannot be excelled elsewhere in the State. It is of the utmost importance that this road should continue to be maintained by the State, as the amount of travel along it between California and Nevada fully justifies it.

Owing to recent important changes in the road, it has been found necessary to re-survey it along its entire route.

Work was begun on September 26, 1900, and the distances given are from the center of the court-house situated in the town of Placerville, in Section 8, Township 10 north, Range 11 east, Mount Diablo base and meridian, from which point to the eastern city limits over the present traveled road is a distance of 1.663 miles.

From this point, which is situated in the center of the county road and on the eastern boundary line of the town of Placerville, a line was run over the said county road, and the various topographical features noted.

At a distance of 3.109 miles, the road crosses the El Dorado Deep Gravel Mining Company's ditch, which said ditch is at the junction of the Newtown and Lake Tahoe Wagon Roads, in Section 10, Township 10 north, Range 11 east, and which is also the west boundary line of that part of the old Placerville and Lake Tahoe Toll Road deeded to the State of California, and of which a map, with field notes, was recorded and filed in the office of the Secretary of State the 30th day of June, 1896. On the former survey, it is to be regretted that no permanent monuments were established, making it necessary for the Department to retrace the entire line of the road. Granite monuments have been now established about every 1,000 feet along the present course, and, so far



Lake Tahoe State Highway, Showing Remains of Old Corduroy Road.

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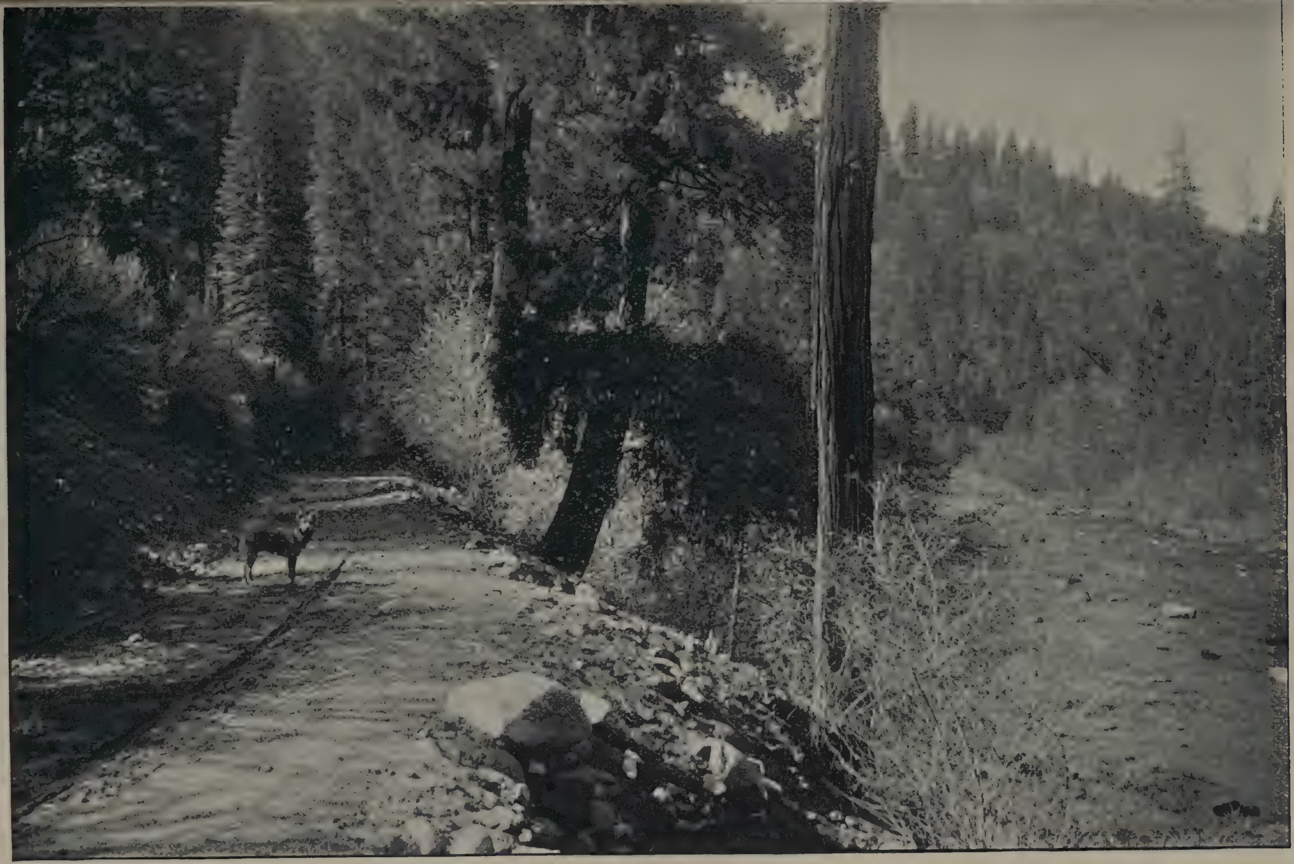

Lake Tahoe State Highway, Showing Bed of American River on Right.

as the survey has progressed, milestones have been erected. (See detailed description, p. 58.) Owing to the early storms, it was found necessary to disband the surveying party on October 31, 1900, after having surveyed 25 miles of the road.

Careful notes have been made of various points of the road that may be bettered by the placing of culverts, changes of grade, etc., and, though work was necessarily delayed on general maintenance of the road during the season, the condition of the road is better than could generally be expected. On account of the numerous short turns, and owing, in places, to the character of the soil due to the mountainous country traversed, it has been found necessary to drain the road with numerous culverts. These culverts, formerly of wood, are being replaced as rapidly as funds will allow by permanent structures of stone and vitrified pipe; and it is recommended that sufficient funds be allowed for the prosecution of further work of this nature.

GENERAL EXAMINATIONS.

Besides having directed the survey of the Tioga and Lake Tahoe roads, your Commissioner has personally examined a number of proposed highway routes throughout the State, recommendations regarding which appear hereafter.

The Department has made analyses of road material submitted to it, has furnished advice to various inquiring counties, has examined maps and plans submitted to it. Boards of Supervisors, commercial institutions, and bodies of representative men, generally, have been conferred with, and meetings of citizens have been attended throughout the State, notably in Stanislaus, in Santa Barbara, in Solano, and in El Dorado counties. A most important Road Convention was attended in Los Angeles in the month of October, 1900, at which numerous papers and addresses were presented on various phases of the road question. A permanent organization, "The Southern California Good Roads Association," was effected, and resolutions were adopted embodying the deliberations and opinions of the convention. Legislation was recommended, covering State aid, classification of highways, an ad valorem tax, etc.

ADVICE TO BE FURNISHED COUNTIES.

While it has always been one of the chief aims of the Department of Highways to coöperate most heartily with the various counties in the State in the matter of road improvement, and to furnish advice on questions of road- and bridge-building, its work in this respect has been somewhat hampered during the past two years by the meagerness of the appropriations furnished it. It is the earnest desire of your Commissioner to enlarge the scope of the Department's work in this respect, to such an extent that all counties desiring tests of materials, bridge plans, and advice in various directions regarding road construction, may be availed of these benefits.

In many counties, where it is necessary to build bridges, engineers have to be hired to make plans, estimates, etc., whereas the Department, if provided with sufficient engineering assistance, could prepare a uniform set of plans and specifications for bridges and roads, and furnish them to those counties desiring them, free of charge; and, as the endurance of a roadbed depends very largely upon the qualities of the stone used, it is of the utmost importance that proper tests of material to be used, as to abrasion, crushing, cementation, etc., be made before work is commenced, and advice given as to the best manner in which to lay the same.

Counties could, in this manner, furnish the Department with samples of all deposits existing within their limits which might be considered useful as road-building materials, and they could be properly classified and designated as to their value in this respect. The matter of tests of road material has received a great deal of attention from the Massachusetts and New York Highway Commissions, as well as from the Maryland Geological Survey, and it has been found a most important factor in determining the actual wear-resisting qualities of various rocks. The Department is at present furnished with a first-class cement-testing machine, and it is hoped that it will soon be able to add other laboratory apparatus in the way of microscopic, photographic, and analyzing instruments, rock-testing machines, etc.

MACHINERY TO BE LOANED TO COUNTIES.

Your Commissioner has already expressed his desire that a number of modern road machines, such as graders, scrapers, rollers, rock-crushers, etc., be purchased by the State, and loaned upon requisition to such counties as are financially unable to furnish themselves with such machinery.

POWERS OF COMMISSIONER REGARDING STATE ROADS.

While the Supervisors of a county have power to prosecute actions for the condemnation of property for county road purposes, and to appear as parties plaintiff to actions against destroyers of county highways or structures, no provision is made in this respect in regard to our State roads and structures, which are not under the control of the county.

It is therefore recommended that authority be vested in the Highway Commissioner to bring action, in the name of the State, in the State or Federal courts, for the purpose of condemnation of property for road purposes, under the right of eminent domain, and that he be empowered to regulate the traffic over State highways and bridges, with power to prosecute offenders.

The importance of vesting the authority of condemnation in a proper party can be realized from the fact that at the present time the right of way for the extension of the Tioga State Road through the Yosemite National Park has been denied by the Secretary of the Interior, and, as it has been decided by the Attorney-General of this State that, inasmuch as no special power is vested in the Highway Commissioner or other State official to commence proper condemnation proceedings, work has, of necessity, been delayed on this important State road, and though available funds are at hand for its construction, and all preliminary work as to surveying, etc., been completed, and contracts ready to be let for actual construction work, the matter will have to rest as it is until such time as the right of way can be secured.

As has been mentioned previously, the State has just completed the building of an excellent stone bridge across the North Fork of the American River, on the Lake Tahoe Wagon Road, and has placed stone milestones along that highway; some road machinery and tools are also owned by the State; and in case such structures, machinery, or tools should suffer destruction at the hands of mischievously inclined persons, or encroachments be made on the State's right of way, it might be a hard matter to decide legally as to who should prosecute the action in the name of the people; and, as a safeguard, and in order the more thoroughly to protect such property, it is recommended that the Commissioner of the Department of Highways be empowered to prosecute all such actions, and to offer suitable rewards, with the approval of the Governor, for the conviction of parties defacing or in any way destroying the road property of the State.

AMENDMENTS TO BONDING LAWS.

It is further recommended that the bonding laws be so amended as to enable incorporated cities to coöperate with the country in the issuance of bonds for road construction.

The Legislature of 1897 passed a bill providing for the construction of an improved highway between Sacramento and Folsom, the State to furnish the material for macadamizing from the Folsom State Prison quarries, while the County of Sacramento was to furnish money for grading, labor, freight charges from Folsom, and work of actual construction, the State thereafter to assume the cost of the maintenance and care of the road.

Inasmuch as no county funds for such a purpose were available in Sacramento County, an election was called by the Supervisors, and 4 per cent bonds, to the amount of $75,000, were voted for, the City of Sacramento voting almost unanimously for the bonds, while the outside precincts carried by over two-thirds majority. However, the proposed sale and issuance of bonds was held to be illegal by the Supreme Court of the State, as it was decided that incorporated cities cannot be taxed for road purposes in the absence of statutory authorization, and that the authority of the Board of Supervisors to expend funds of the county in constructing county roads is limited to localities outside of incorporated cities, and no tax can be levied by them for county road purposes upon any property within an incorporated city. (*Devine* vs. *Board of Supervisors of Sacramento County et al.*, 121 Cal., p. 670.)

Therefore, only a few of our smaller and more sparsely settled counties can be bonded for road purposes under the present law, and in these counties the issuance of bonds is impracticable; and, until such amendments to the law are made as will enable incorporated cities to be taxed in this manner, no help can be looked for in this direction, which has proved of great advantage in other States.

The readiness of the city to join with the county in road construction was set forth in the returns of the Sacramento County bond election, when the city carried by over 91 per cent, as against a 74 per cent vote of the country.

STATE ROAD MAPS.

It is the desire of the Department to compile sectional road maps, each section to cover certain portions of the State, in order that the public may be given the benefit of a reliable system of State road maps, which is not in existence at the present time. No appropriation has heretofore been made for this purpose, but the expense of such compilation, together with the necessary drafting work, publishing, etc., could be well carried out by the creation of a "revolving" fund, the proceeds from the sale of the maps to the public returning to the fund, allowing the work of compilation and publication to proceed without expense to the State. The demand for such a system of road maps is universal throughout the State, and certainly justifies the creation of a fund along the lines suggested.

NECESSITY FOR STATE AID.

BAKERSFIELD-SANTA BARBARA ROAD.

The importance of a highway, serving as a direct outlet to the coast from that portion of the San Joaquin Valley embraced in Kern County, can be best appreciated by an examination of the present existing conditions.

Bakersfield, as the center of the great oil-fields of the State, as a railroad town, and as the principal city of an important farming and stock-raising community, demands such an outlet to the sea. The nearest existing road from this city over the Coast Range to the north is from Stanislaus into San Benito County, a distance of about 250 miles, and that to the south is from Ventura County into Los Angeles County. It will thus be seen that the great San Joaquin Valley has practically no interior outlet throughout its entire length.

In 1899, it was pointed out to the Department of Highways that a road leading directly from Kern into Santa Barbara County, along the proposed Bakersfield-Santa Barbara route, would be not only centrally situated geographically, but would meet the demands of the most thickly settled communities in the interior of the valley. Accordingly, an examination of the proposed route was made in the spring of 1900, and another in the fall of the same year. It was found that the construction of the road in view is entirely feasible, being susceptible of good location as to grade, and passing through a country well watered by mountain streams. Such a road would be but 80 miles in length, and could be traveled by heavy wagons in two days; whereas, at present, the ocean cannot be reached by wagon-road except through Pacheco Pass, in Stanislaus and San Benito counties on the north, and through Ventura County to the south. By the construction of such a road, not only would the people of the counties of Kern and Santa Barbara be benefited, but the valley counties of Tulare, Fresno, Kings and others, would be given the advantage of easy access to the coast, and travel to the valley from the coast counties of Santa Barbara, San Luis Obispo, and Ventura would be facilitated. It will thus be seen that such a road is by no means local in its importance. It would form a natural geographical and commercial outlet from the great interior valley of California to the sea, and would benefit a large portion of the State.

TEJON PASS ROAD.

The Tejon Pass forms the only traveled highway at present between Southern California and that portion of the State to the north, with the exception of the coast road, and though geographically the most feasibly situated outlet, the sparseness of population and the poor section of country which it crosses have made it impracticable for this road to be kept in a fit condition to travel. This road, leading from Los Angeles County into Kern County, forms the connecting link between Southern California and the San Joaquin Valley, joining together two rich and fertile portions of the State, and should be supported by the State at large.

SACRAMENTO-YOLO ROAD.

During the heavy floods of winter, which overflow the flat and low-lying lands at the junction of the Sacramento and San Joaquin valleys, communication between these two valleys by a direct route is at present impossible, and, though the northern counties demand the construction of a direct road, it has been found financially impossible for the county of Yolo individually to build a road and keep it open during the winter storms. The maintenance of about 10 miles of such a road, lying between Sacramento and Yolo, should be assumed by the State.

HUMBOLDT-SHASTA COUNTY ROAD.

A glance at a map of California will show the relative position of the counties of Humboldt and Shasta; the county of Trinity, with a population of but 4,383, lying between. The most expensive portion of a road passing directly from one of the first-named counties to the other would necessarily have to traverse Trinity County, which is unable to bear the burden of such expense, and thus it is that the traveler has the choice of two roundabout routes. Traveling from Eureka, the nearest road to the south is in the vicinity of Clear Lake, in Lake County, and, to the north, through Grant's Pass, in Oregon, leaving a stretch of about 250 miles between these two points without an opening either east or west. The construction of about 40 or 50 miles of road, completing the chain from Redding, through Weaverville to Eureka, should be borne by the State; otherwise, the mountain range between the coast and Trinity County is likely to remain untraversed by a road for years to come.

TALLAC–M'KINNEY'S.

The construction of a road between Tallac and McKinney's, as forming part of the Lake Tahoe State Wagon Road system, properly comes under the jurisdiction of the State. There is a road in existence at present from the Lake Tahoe State Wagon Road to a point about 2 miles north of Tallac, which is situated at the south end of Lake Tahoe. There is also a road coming from the north, running to McKinney's, which is on the north end of the Lake; but the chain is there broken, for lack of a connecting link of about 8 miles. In order to reach McKinney's from Tallac at present by team, it is necessary for one to travel back to Placerville, thence to Auburn, up through Colfax, Dutch Flat, Emigrant Gap, etc., to Tahoe City, and thence to McKinney's, reversing the process for travel from McKinney's to Tallac; or the traveler has his choice of going by way of Nevada, over a route almost as long. To one having horses and wagon, the steamer rates are prohibitory. The construction by the State of these 8 miles of road is recommended, and also the improvement of about 35 miles of road between Tahoe City and the present State Wagon Road.

NATIONAL PARKS TO BE OPENED UP.

The Mount Whitney and Kings River country, in which lie the Sequoia and General Grant National Parks, is practically unknown to the average resident of the State, and much more so to the tourist in California. The Giant Forest, situated in the Sequoia National Park, contains thousands of trees towering more than 300 feet above the ground, at an altitude of about 7,000 feet; the Kings River, the Kaweah River, and the Kern River cañons diverge into this country, all of them containing scenic beauties not excelled by the Yosemite. It is recommended that the coöperation of the Federal Government be solicited, looking to obtaining some assistance in the way of making these national reservations of more benefit to the public.

APPENDIX A.

REPORT OF THE COMMISSION ON ROADS IN YOSEMITE NATIONAL PARK, CALIFORNIA.

UNITED STATES ENGINEER OFFICE, PACIFIC DIVISION,
SAN FRANCISCO, CAL., December 4, 1899.

SIR: The Yosemite National Park Commission, constituted by paragraph 28, Special Orders No. 100, Headquarters of the Army, Adjutant-General's Office, Washington, April 29, 1899, * * * has the honor to submit the following report:

The Commission assembled at San Francisco, Cal., on May 27, 1899, and organized. After a general discussion of the duties with which the Commission is charged by the terms of the Act, and of the means and method of their execution, it was found desirable to have possession of maps and documents bearing upon the subject of our investigation, and your instructions for our guidance. Accordingly, a letter was drafted and addressed to you under date of May 31, 1899, reporting the Commission as ready to enter upon its duties with the least practicable delay, and asking to be supplied with the desired information and instructions.

Upon the receipt of your reply thereto, the Commission proceeded to Wawona, Cal., and began the work in the field on July 11th. Just prior to this date, Mr. Price, ceasing to be a member of the Department of Highways of the State of California, retired from the Commission as a member, and was succeeded by Mr. Joseph L. Maude, under appointment of the Honorable Secretary of War.

Captain Harry C. Benson, having been designated by the Honorable Secretary of War to act as a special disbursing officer for the Commission, preceded the other members to Wawona, in order to arrange equipment and means of transportation supplied to the Commission by the Quartermaster's Department of the Army, and to organize the expedition.

Leaving Wawona on the 13th of July, the Commission proceeded with its wagons and pack train over the Wawona Road to the Yosemite Valley, thence over the Big Oak Flat Road to Hodgden's, thence to and over the Tioga Road to the Tuolumne Meadows at the junction of the Dana and Lyell forks of the Tuolumne River. Much delay was encountered on the Tioga Road due to fallen trees, which had to be removed; broken bridges, and burned and rotted-out culverts, which had to be repaired, and to washouts, which required filling. Just beyond the last-mentioned point a slide in the mountain side prevented the further advance of the wagons without the expenditure of considerable time and labor for repair, so the Commission proceeded thence by saddle animals and pack train, over a good wagon road, as far as Tioga, the end of the old Sierra wagon road, and thence by trail to the inspection of routes leading over the summit.

The return was made over the same route as far as Crane Flat, where terminates a branch of the Coulterville Road, which took us to Hazel Green on the main Coulterville toll-road leading into the valley; this was followed to Big Meadows. Here saddle animals and pack train were taken again, and the wagons sent on to the Cascades to await our arrival there.

The Commission went over McCauley's Hill a short distance by wagon road, and thence by trail to the mouth of Crane Creek, and followed a trail along the north bank of the Merced River Cañon to the western boundary of the National Park; the return trip was made upon the south bank of the river as far as practicable, following the old Mariposa County trail, which crosses to the north side of the river near Hennessy's and continues on to the Cascades, at which place the wagons were picked up and the Commission arrived at Wawona July 27th.

Subsequently, the Commission, with saddle animals and pack train, proceeded by shortest trail to Tioga, to examine in detail the several routes connecting with roads traveled by wagon in Mono or Inyo counties. There are three possible routes across the dividing ridge of the mountains, namely, the Mill Creek, the Levining, and the Bloody Cañon, in the order named, from north to south, and all were traversed by the Commission, and incidentally a trip was made over a good trail, from the Tioga Road to the foot of the Lyell Glacier, prior to the return to Wawona September 1st.

Later, the Commission proceeded, with saddle and pack animals, to Hog Ranch, and began an examination for a wagon road into the Hetch Hetchy Valley.

The trail into Poopenant Valley was taken with the possibility of finding a suitable route for a wagon road therein along the bed of the river. Such was found impracticable, and the trail to McGill's was followed and the valley entered from the north. Two days were spent in examining possible exits from the valley, after which the return was made by direct trail to Hog Ranch and on to the Tioga Road.

The question of a wagon road through the Tenaiya Cañon, to furnish a direct route from the valley to the northeastern portion of the National Park, received attention, and although it was reported to be entirely impracticable even for a trail, nevertheless the Commission proceeded to

Lake Tenaiya, and one of its members, Mr. Maude, essayed the cañon on foot, and succeeded with great difficulty in passing through.

The Commission reached Wawona September 17th. There remaining only to consider the road entering the Park from the west, the Commission removed to Mariposa, and operated from this point in an examination of several proposed routes, especially the Merced River route. Several days were passed hereabouts on horseback, in covering trails and roads to and along the river, and points on the river were visited and examined. This completing the field work of the Commission, it returned to San Francisco and entered upon the preparation of its report. The results of all these investigations are succinctly given under separate headings.

At Wawona, Cal., September 1st, a hearing was given to a delegation of the Mariposa Board of Supervisors, presenting to the Commission certain plans and surveys of routes to the Yosemite Valley for its consideration, and at Mariposa two days were devoted to hearing the views of delegates from the Merced Board of Trade and from the Mariposa County Supervisors and from the town of Le Grand, in Merced County, and others present and interested in the matter, and an examination of the records of these surveys in the archives of the county court-house.

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THE BIG OAK FLAT TOLL-ROAD.

The western terminus of this road is somewhat indefinite, but it is near to the dividing line between Mariposa and Tuolumne counties, in Section 27, Township 1 south, Range 17 east, Mount Diablo base. It runs in a generally due easterly direction for a distance of about 9 miles, when it enters the Yosemite National Park at about midway of its western boundary, and continues on easterly to the boundary of the original Yosemite Valley grant to the State of California, at Gentry's.

According to Wheeler's survey, the length of the road within the National Park is 19.03 miles; it is, on an average, 13 feet wide, and has a maximum grade of 16 per cent. During all seasons while open to travel it is kept in good condition and repair. The road was completed in 1874 by the Yosemite Turnpike Road Company, a corporation under the laws of the State of California. It originally extended about 4.37 miles farther east, to the floor of the Valley, but this portion was purchased by the State in 1886. The ownership of the road is now vested in the Big Oak Flat and Yosemite Turnpike Road Company, a corporation created on the 3d day of June, 1879, and existing under the laws of the State of California, and holding a franchise duly granted to collect tolls on said road for fifty years from date of incorporation of the Yosemite Turnpike Road Company, January 20, 1871.

The original cost of the road is stated at approximately $40,000, to which amount should be added the subsequent betterments, such as bridges, changes of grades, and other improvements, to make up the total cost of the road, in the estimation of its owners at the present day, $45,000. The Commission is satisfied that the amount stated was required at the time. It is a dirt road, pure and simple, from its western end to the borders of the Yosemite Valley grant at Gentry's, and, in the opinion of the Commission, could be built at the present day for about $30,000, with probably better grades and alignments.

The road begins with an elevation of about 3,000 feet above the sea-level, descends to 2,650 feet at the crossing of the South Fork of the Tuolumne River, and then ascends gradually to an elevation of 3,970 feet before reaching Hardin's (elevation, 3,550 feet), in a distance of 4.39 miles. From here the road ascends quite uniformly for a distance of about 11 miles, to the Tuolumne Big Tree Grove (elevation, 5,650 feet), passing through Crocker's (elevation, 4,452 feet), and Hodgden's (elevation, 4,673 feet). Thence the road climbs 1 mile to Crane Flat, at an elevation of 6,350 feet, and 2 miles more to the summit, 7,250 feet. From this point it descends with a uniform grade through Tamarack (6,390 feet), and Cascade Creek (6,150 feet), to the floor of the Valley at about 4,000 feet in a stretch of 10¼ miles. The average grade of the road may be fairly stated as 8 per cent, there being places where a grade as high as 16 per cent is encountered.

In estimating the cost of the construction of the road three classes of work should be considered: First, that portion where the roadway is over flat or gently sloping ground, where no particular excavation or fill is necessary, of which there are some 14 miles, would cost $500 per mile, or $7,000; second, the roadway along the hillsides, with cut and fill, approximating 15 miles in length, at $1,200 per mile, $18,000; and, third, along where rocks and bowlders have to be blasted, and retaining walls built, aggregating 1 mile, at $5,000; giving a total of $30,000 for the entire road, were it to be built to-day.

The annual cost of maintenance of this road is stated at $350. The rate of tolls are fixed annually by the County Supervisors, and the present rates of toll for travel are:

For each person, each way	$1 00
For one two-horse team, each way	3 00
For each additional animal	50
For each footman, each way	50
For loose cattle and horses, per head	10
For sheep and hogs, per head	05

The annual tolls collected for the period 1869 to 1880 appear to have been $2,567.50, and for the past five years $1,781.90.

The season open to travel, and actually traveled by the public, is from about May 15th to November 1st, depending upon the character of the seasons. The stage company runs its stages from about June 1st to August 15th, outside of which the travel is so light as not to warrant the keeping up of the stage service.

THE COULTERVILLE TOLL-ROAD.

This road begins at Bower Cave, in Mariposa County, and running in a generally easterly direction, crosses the boundary line of the Yosemite National Park about 9 miles from the initial point, passing on to the "Blacksmith Shop" as its terminal point, about 1⅛ miles west of the boundary of the Yosemite Valley grant; its total length, as defined above, is 29.04 miles. In addition thereto is a branch joining Hazel Green with Crane Flat, a station on the Big Oak Flat Road, the length of this branch line being 4.76 miles.

According to the Wheeler survey, the length of the main road within the limits of the National Park is 19.5 miles, and the branch line is wholly within the limits of the Park, 24.26 miles.

The construction of this road was begun in 1870 by the Coulterville and Yosemite Turnpike Company, a corporation organized and doing business under the laws of the State of California, and was finished in 1874. It originally was built to the floor of the valley, 4 miles beyond its present terminus, but in 1886 this portion was purchased by the State of California, under an Act of the Legislature, and made free. The ownership of the road is still with the original builders, the Coulterville and Yosemite Turnpike Company.

* * * * * * * * * * *

(The information regarding cost of construction, rates of toll, etc., is derived from a statement furnished to the Commission by its president, and appears in the original report of the Yosemite Commission, and marked as "Exhibit B.")

* * * * * * * * * * *

The cost of construction is shown to be $71,000 for the entire road from Bower Cave to the floor of the valley, including the branch line to Crane Flat. In betterments, from time to time, $14,000 has been expended, thus bringing the cost up to $85,000. Ten thousand dollars was paid by the State for the short piece of road between the "Blacksmith Shop" and the floor of the valley; so the remaining portion of the road would seem to have a value of $75,000. Considering the wage rate for labor at that time, as well as the cost of tools and excessive cost of explosives, the Commission is satisfied that the estimates given it by the company are correct. However, considering the present cost of labor and materials, it is unquestionable that the road could be constructed now for very much less money. It is estimated that a road equally as good, along practically the same route, could be constructed for about $50,000, and with this amount of money better alignments and grades might be secured than those existing on the present road.

A more detailed description of the road follows: Beginning at the initial point, Bower Cave, at an elevation of 2,500 feet above sea-level, the road crosses the western boundary of the Yosemite National Park at an elevation of 5,150 feet at a distance of 9½ miles; thence, it continues to ascend to an elevation of 6,050 feet on the top of Sugar Pine Ridge in a distance of 5 miles, passing through Hazel Green at an elevation of 5,665 feet. From Sugar Pine Ridge a descent is made to Big Trees, elevation 5,400 feet, in a stretch of 1½ miles. To the crossing of Little Crane Creek the road continues to descend to a level of 4,600 feet in 5 miles, and ascends through 1.45 miles to the top of the divide, 4,800 feet. The descent from this point is made to Big Meadows, 2 miles distant, at an elevation of 4,350 feet. A rise is made from here to 4,650 feet in a stretch of 1 mile, and a final descent to the "Blacksmith Shop," elevation 3,500 feet in a distance of 3.59 miles.

The salient points of the profile only are given, there being, of course, many undulations in the grade. The major portion of the grade may be stated as being 8 per cent, though in some places a grade of 16 per cent is attained.

The width varies from 8 feet to 20 feet, and is sufficient for teams to pass one another, save in places where the roadway was necessarily restricted in width by reason of costly construction, and here suitable turnouts are provided.

The cost of maintenance of the road for the period from 1874 to 1880 is given as $1,000 per year; from 1880 to 1890, $750; and since then, $600.

In the construction of this road, three classes of work should properly be considered in arriving at its approximate value:

First, that where the road runs over comparatively level or gently sloping ground, and where the principal work consists in clearing the way of small and medium-sized trees, in crowning the roadbed, and ditching. Taking the main road, there are in the aggregate 7 miles of this class which could be built for $600 per mile.

Second, side-hill work, where there would be required considerable "cut and fill," timber to be cut and removed, ditches and culverts constructed. The cost of this class of work is put at $1,400 per mile, and there are about 20 miles of it in the main road.

Third, rock work. The removal of large bowlders and the construction of retaining walls characterize this class, and is estimated to cost $6,000 per mile, and there are about 2 miles of it.

The branch road is estimated to cost about $1,000 per mile.

The following is a summary:

7	miles, at $600 per mile	$4,200
20	miles, at 1,400 per mile	28,000
2	miles, at 6,000 per mile	12,000
4.76	miles, at 1,000 per mile	4,760
	Total cost	$48,960

The road is kept in good condition during the season of travel, which generally is from April to November, but this period is dependent upon the character of the season. During some winters which were milder and freer from snow than the ordinary winters in the Sierras, the road could be traveled the entire year, but such winters are exceptional.

The Board of Supervisors of Mariposa County fixes annually the rates of toll to be charged, and the rates are not materially changed from year to year. They are:

For passenger teams, per passenger	$1 00
For horse and rider	1 00
For freight teams loaded, per animal	1 00
For freight teams empty, per animal	50
For pack animals, each way	75
For animals loose, each	37½
For sheep and hogs, each	10
For bicycle and rider	50

The annual tolls collected are stated to have been to the year 1891, $2,500; from 1892 to 1898, inclusive, $1,000; or a total revenue from tolls of $33,932.71 to date.

WAWONA TOLL-ROAD.

The Wawona Road, as generally understood, has its initial point at Raymond, in Madera County, the terminus of the branch line of the Southern Pacific Railroad from Berenda to Raymond, and extends thence in a northerly direction, entering the south boundary of the Yosemite National Park at Wawona, and continues northerly to the Yosemite Valley, a total distance of 73 miles, of which length 26 miles are within the limits of the Yosemite National Park, and 7 miles lie wholly within the limits of the Yosemite National Grant. In addition to this main line of travel, a branch line from the town of Mariposa makes junction with the main line at a point about 1 mile south of Wawona. Another branch leaves the main road at Four-Mile Station, some 4 miles to the south of Wawona, and runs thence in a meandering but generally easterly direction to the State grant surrounding the Mariposa Grove of Big Trees. Another branch leaves the main road at Chinquapin Station, about midway between Wawona and Yosemite Valley, and runs in a northeasterly direction to Glacier Point, which overlooks the Yosemite Valley near its head.

Not all of the road described above is toll-road. On the main branch from Raymond to Yosemite, from a point 8 miles north of Ahwahnee, to a point on the boundary line between Madera and Mariposa counties, the road is maintained by the owner of the Miami sawmill, Dr. Cassell, of Iowa, and tolls are collected. At the boundary line begins the main toll-road, known as the Wawona toll-road, owned and controlled by the Yosemite Stage and Turnpike Company.

Starting with an elevation of 5,200 feet, the road descends in a distance of 3 miles to Summerdale at an elevation of 4,900 feet; thence to the Four-Mile Station, a distance of 3 miles, 5,000 feet is reached; then

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the descent is made to 4,028 feet at Wawona, in a distance of 4 miles. Eight-Mile Station is 8 miles beyond, with an elevation of 5,520 feet, and at a farther distance of 5 miles, 6,390 feet, the highest point in the road is reached. From here the road descends to Grouse Creek, elevation 4,650, in 4 miles, and then ascends to Fort Munroe, with an elevation of 5,330 feet, in a stretch of 2 miles, and here entering the boundary of the Yosemite Valley grant drops to the floor of the valley. The portion, however, from Fort Munroe to the floor of the valley was purchased by the State of California, and is now a free road.

Ownership is vested in the Yosemite Stage and Turnpike Company, a corporation existing under the laws of the State of California, who, at our request, submitted a detailed report (original of which appears as "Exhibit C" in the Report of the Commission on Roads in Yosemite National Park), from which we extract the following data: The cost of maintenance of that portion of the road from Madera County line to the valley, for a period of seventeen years, has averaged $2,465.20 per annum. The cost of construction was $52,000, which, considering the conditions prevailing at the time, was exceedingly reasonable. The company is unable to segregate the amount of tolls collected from each branch, so this matter will best be presented later on. The tolls collected are annually fixed by the Board of Supervisors of Mariposa County, and are at the present time as follows:

South Fork and Yosemite Road.

For horse and buggy, or other vehicle, each horse	$1 00
For freight teams loaded, per animal	1 00
For freight teams empty, per animal	50
For horses and mules and rider	1 00
For animals packed, each	75
For animals loose, each	25
For sheep and hogs, each	10

Road from Wawona to Boundary Line Between Mariposa and Madera Counties.

For horse and buggy, or other vehicle, each horse	$1 00
For freight teams loaded, per animal	1 00
For freight teams empty, per animal	50
For animals packed, each	50
For horses, mules, or oxen, each, loose	25
For sheep and hogs, each	10
For horse and rider	50

Bridge South Fork of the Merced River, near Wawona.

For horse and rider	$0 25
For animals loose, each	05
For animals packed, each	10
For sheep, hogs, and goats, per 100	75
For horse and buggy, each horse	25

The company maintains this road open to travel from April to December, and some years during the entire winter, depending on the character of the season.

The road construction purposes may be divided into three classes: Sidehill work, with "cuts and fills," as general characteristics of the road, and a much heavier class of side-hill work, involving heavy "cuts and fills," with high retaining walls, and the removal of rocks and trees. The first class would cost $1,200 per mile, there being about 20 miles of this class of work. Of the second class, $2,000 per mile would be necessary for construction; of this class there are 8 miles. While for the third class, rock work with heavy retaining walls, the aggregate length would be about 1 mile, and would cost $5,000, making the total cost for the road $46,000, the grade varying from zero to 10 per cent; in some few places for short distances, 12 per cent; by far the major portion of the grade approximating 6 per cent. The width varies from 8 to 20 feet, and there are but few places where teams cannot pass, and those for only short distances of 100 to 200 feet. Its present condition, for a mountain road, carrying such heavy traffic, is very good.

MARIPOSA BRANCH.

The portion of this road upon which tolls are collected begins at a point 2½ miles east of White & Hatch's sawmill, and covers the road to a junction with the main line at a point about 1 mile south of Wawona. The initial point has an elevation of 3,500 feet, and the road rises to the summit of the Cowchilla Mountains, an elevation of 5,800 feet, in 6 miles, descending from there to the junction with the main line, at an elevation of 4,450 feet. The grades vary from zero to 14 per cent. The width of this road permits the passing of teams at all points, and will readily average 16 feet. The ownership is vested in the Yosemite Stage and Turnpike Company, who maintain the road in fair condition. Their report of the cost of maintenance, covering a period of seventeen years, gives an average of $681.50 per annum. They also report its cost at $15,500, which seems to us a reasonable estimate, but we think that $14,000 would construct this road at the present day, and, possibly, with the same amount of money, better grades could be obtained. The tolls collected cannot be segregated for this branch. The rates of toll, as allowed by the Board of Supervisors, are as follows:

Road from White & Hatch's to Wawona.

For horse and buggy, or wagon	$1 00
For two horses and buggy, or wagon	2 00
For each additional animal in teams of all kinds	1 00
For freight teams empty, per horse	50
For ox teams	The same as horse teams.
For saddle animal, with rider	50
For animals packed, each	25
For loose horses, mules, or cattle, each	20
For hogs, sheep, and goats, each	05

This road is open to the public from April 1st to December 1st, or longer, the length of time dependent on the character of the season.

CHINQUAPIN BRANCH.

This branch extends from Chinquapin Flat to Glacier Point.

Beginning at Chinquapin, at an elevation of 6,250 feet, ascent is made to the divide, at an elevation of 7,650 feet, in a distance of 4 miles. Thence it descends to 7,000 feet at the crossing of Bridal Veil Creek, which is reached in a distance of 2 miles. Ascending again, the road reaches an elevation of 7,900 feet, near Ostrander Rock, where it crosses the boundary line of the Yosemite Valley grant. Continuing on practically this level, the road passes to the southeast of Sentinel Dome, at an elevation of 7,800 feet, and from there descends to an elevation of 7,300 feet at Glacier Point, a distance of 4 miles from Ostrander Rock, the total length of the road being 14 miles, of which amount 4 miles is within the boundary of the Yosemite Valley grant. The grades on this road vary from zero to 14 per cent, and the width is sufficient at all places for teams to readily pass one another. The ownership of the road is vested in the Yosemite Stage and Turnpike Company, who maintain the road in good condition. The cost of maintenance of this road averages about $850 a year. The cost of construction, as shown by the company's report, was $8,000, an exceedingly reasonable cost, and we are satisfied that the road could not be constructed at the present time for a less sum of money. The amount of tolls collected on this branch has not been segregated by the company in its report. The rates of toll, as allowed by the Board of Supervisors of Mariposa County, are as follows:

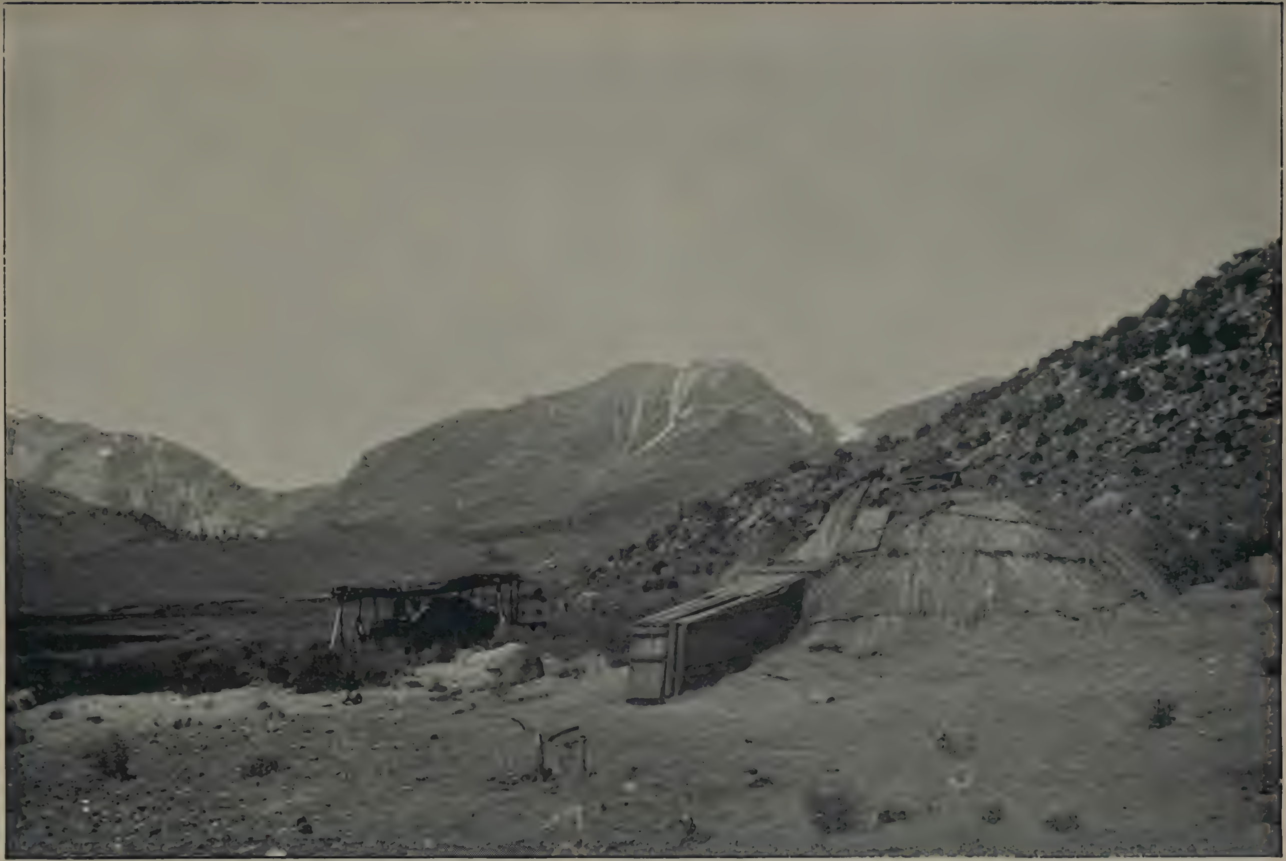
Road from Chinquapin to Yosemite Grant, Near Glacier Point.

For freight teams, per horse, loaded	$0 25
For freight teams, per horse, empty	12½
For horse and buggy, or other vehicle, per horse	25
For horse and rider	12½
For loose horses, mules, and cattle, each	05
For sheep, goats, and hogs, each	02

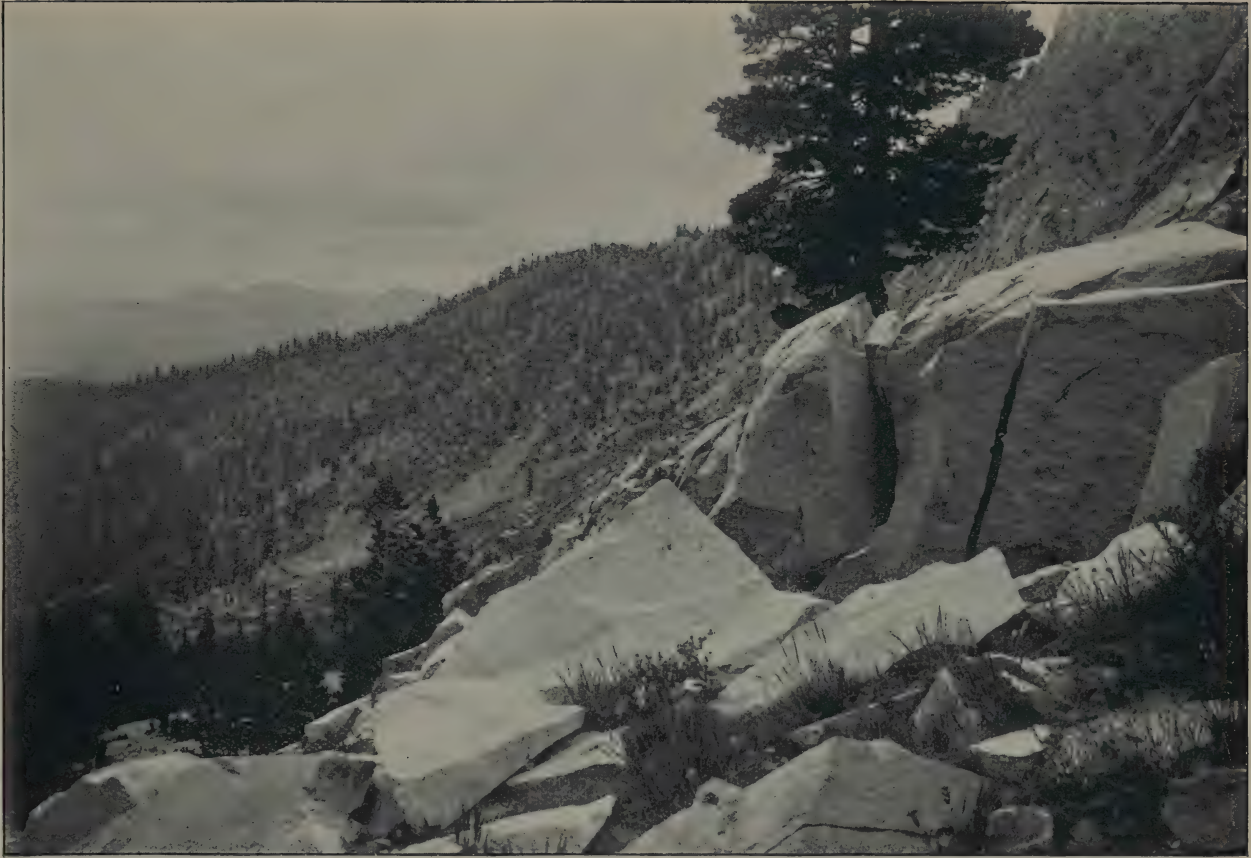
This road is open for travel from the 15th of June to the 1st of November.

THE BIG TREE BRANCH

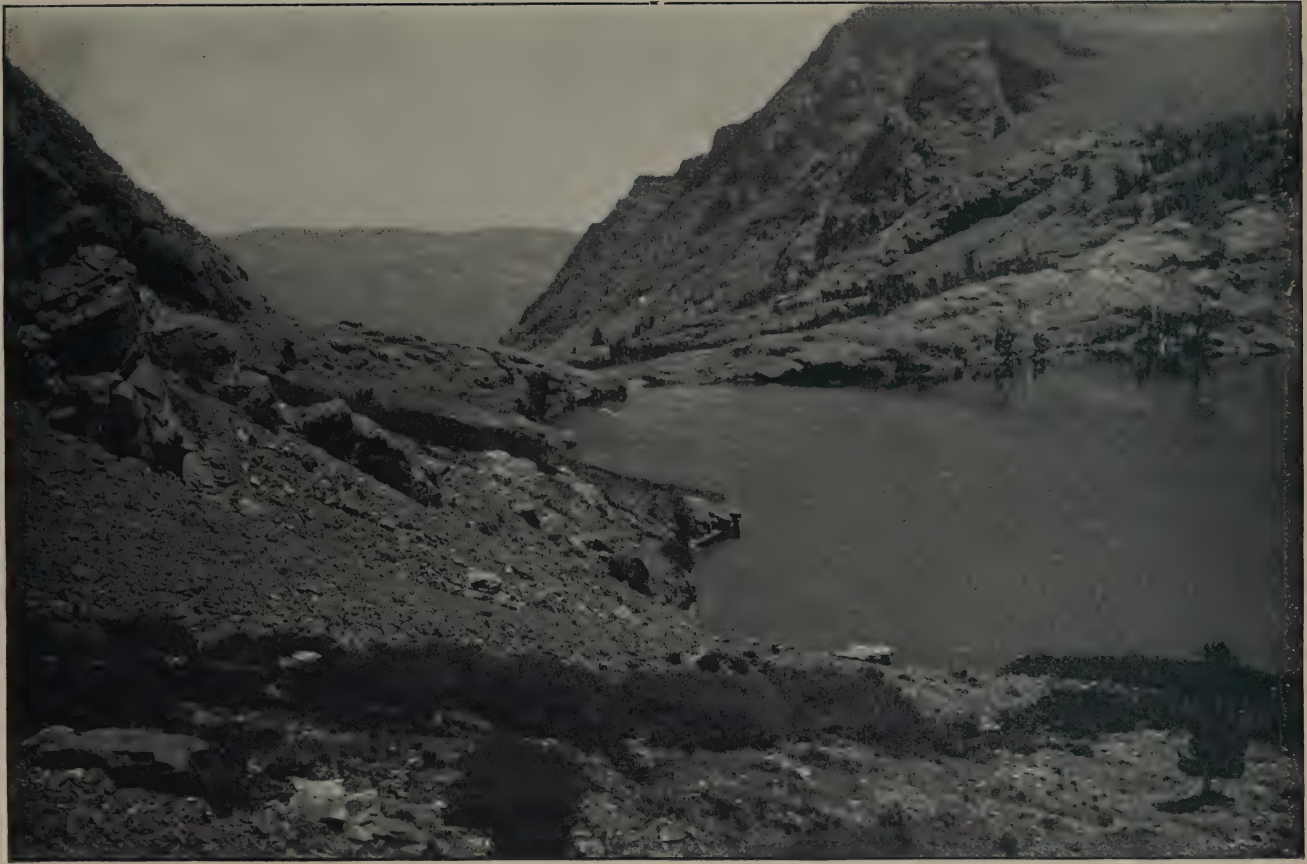
Is a road branching from the main line between Raymond and Wawona, and giving access to the Mariposa Big Tree Grove. Leaving the main road at Four-Mile Station, at an elevation of 5,000 feet, the road extends thence in a general easterly direction, but is exceedingly meandering in character, and crosses the boundary line of the Mariposa Big Tree Grove at an elevation of 5,600 feet, at a distance of 2 miles, the grades varying from zero to 10 per cent. The width is sufficient at all times for teams to pass. The ownership is vested in the Yosemite Stage and Turnpike Company, who maintain it in good condition. The cost of maintenance of this branch is included in that of the main road. The statement shows the cost of construction to have been $1,250, a very reasonable



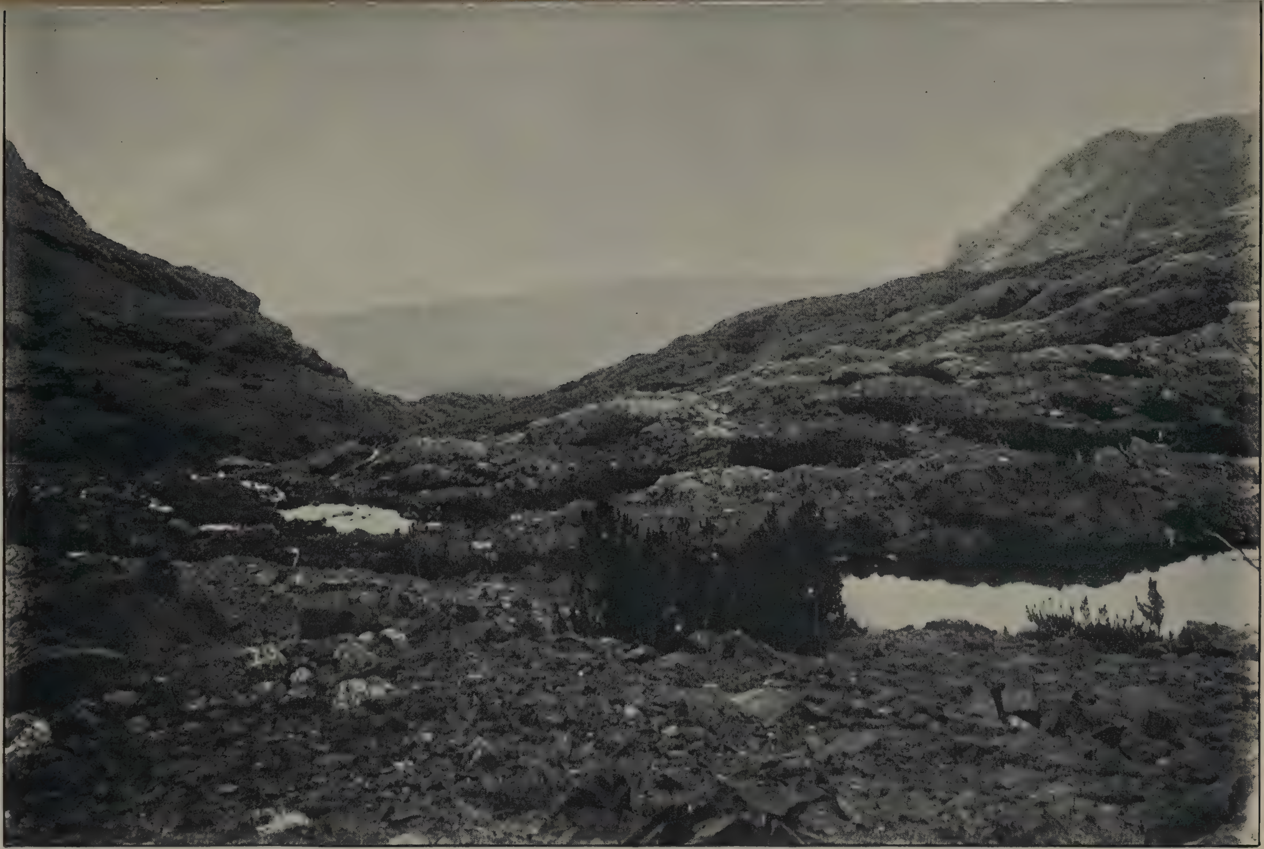
Mono Pass—Mount Gibbs on Right, Mount Parker on Left--Indian Wickiups in Foreground.



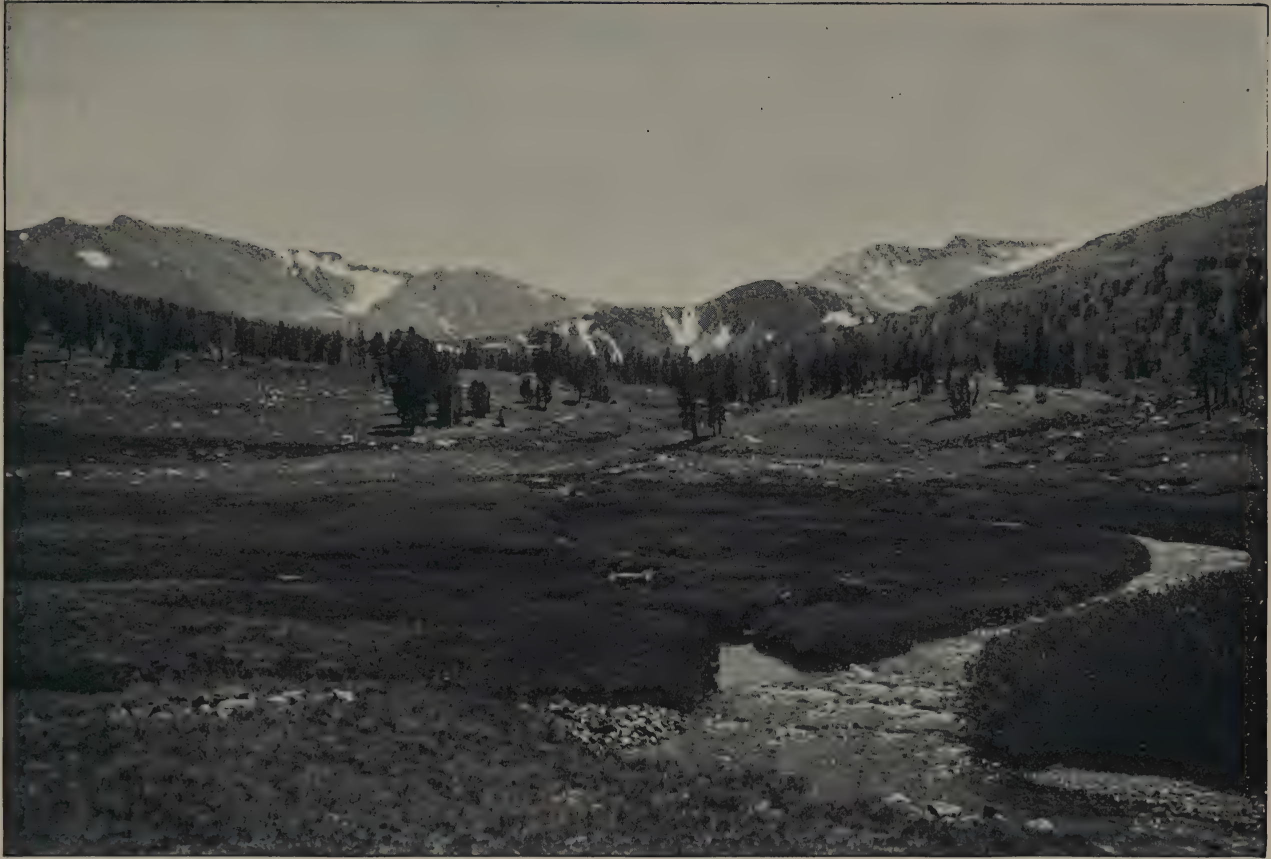
Spur of Mount Parker, Line of Extension of Tioga Road.



Outlet of Sardine Lake. Elevation, 9,883 Feet. Line of Extension of Tioga Road.



Above Sardine Lake, Looking East. Elevation, 10,510 Feet. Line of Extension of Tioga Road.



MOUNT PARKER (WEST SIDE), AS SEEN FROM EXTENSION OF TIOGA ROAD

amount, and one which would be necessary at the present time to duplicate the road. The tolls collected have not been segregated in this instance by the company, but the rates, as allowed by the Board of Supervisors, are as follows:

From Wawona to Big Tree Grant Line.

For freight teams loaded, per animal	$0 50
For freight teams empty, per animal	25
For horse and buggy, or other vehicle, per horse	50
For animals packed, each	25
For horses, mules, or oxen, loose, each	12½
For sheep and hogs, each	05
For horse and rider	25

This road is open for travel from April to December.

Summarizing the roads owned and controlled by the Yosemite Stage and Turnpike Company would give the following:

1. Cost of construction of roads	$76,750 00
2. Cost of maintenance of roads, 17 years	65,636 78

Cost of construction includes the bridge spanning the South Fork of the Merced River at Wawona, and is for a total mileage of between 59 and 60 miles. We believe that these roads can be built at the present day for $70,750. The tolls collected over the entire system of roads owned by the company appear to have been $221,254.11 for a period of seventeen years, from 1882 to 1898, inclusive. Had an accurate account been kept previous to 1882, this amount would have been increased from 15 to 20 per cent, as shown by the statement of the company.

TIOGA ROAD.

The proper name for this road is "The Great Sierra Wagon Road." The initial point is in Section 34, T. 1 S., R. 19 E., near Sequoia Postoffice, and, keeping in this tier of townships, the road runs in a general easterly direction until it reaches the eastern boundary of the Yosemite National Park, near the northern part of T. 1 S., R. 25 E. Outside the boundary it turns and continues due north for a distance of 6 miles to the Tioga mines. Its length is 56.15 miles, about 51 miles of which are within the limits of the Yosemite National Park.

With the initial point 4,450 feet above the sea-level, the road descends through 2.2 miles to the South Fork of the Tuolumne River, at 4,160 feet, then ascends with an easy grade to 6,380 feet at Aspen Valley, in a distance of 8.36 miles; continuing to ascend, the lower crossing of the Middle Fork of the Tuolumne River, with an elevation of 7,000 feet, is reached in 4.3 miles; and White Wolf, 8,090 feet, in a farther distance of 5.62 miles; and the summit, 8,550 feet high, 2.56 miles beyond. From here is a gradual descent to the crossing of Yosemite Creek, 7,200 feet, in 3.85 miles, when the road again ascends, passing through Porcupine Flat, 8,000 feet, distant 3.84 miles; thence through 5.19 miles to

Snow Creek Divide, elevation of 8,700 feet. From here to Lake Tenaiya the grade is a descending one, the elevation of the lake being 8,146 feet, and the distance 2.81 miles. From this point the grade ascends to the summit, with an elevation of 8,690 feet, in a distance of 2.95 miles. It then descends to the Tuolumne Meadows, with an elevation of 8,550 feet, in a distance of 5.38 miles. Beyond, the ascent is gradual until the summit of McLean's Pass is reached, with an elevation of 9,941 feet, in a distance of 7.03 miles. From McLean's Pass to the terminal point, Tioga, with an elevation of 9,795 feet, is 2.06 miles. (A profile of the road accompanies the original report.)

There is no uniform grade to this road, it varying from zero to 10 per cent. The road, however, was skillfully laid out, and it may safely be said that most of it has a grade of only 3 per cent. The width varies from 10 to 20 feet, the greater portion being about 14 feet, and there can be no difficulty in teams passing one another at almost any point, but at the narrower points along the road suitable turnouts are provided.

The present owner of the road is Captain Rudolphus N. Swift, Acushnet, Mass., and he has furnished us a report showing titles, cost of construction, rates of toll, etc., * * * from which it appears that the original cost of construction was $62,000. The Great Sierra Consolidated Silver Company was the original constructor of this road, and it was exceedingly well built, the bridges having fine stone abutments, and there is a particularly well-built section of sea-wall along the shore of Lake Tenaiya. Retaining walls were located wherever there was the least necessity for them, and all are well constructed. The surfacing of the road was originally good, but now practically all gone, and many of the timbers in the bridges are rotten. The Commission, on its tour of inspection over the road, was obliged to make repairs, and to replace rotten timbers before passage could be made over the bridges. The retaining walls in a few places have given way, and the surface of the roadbed has been badly washed, heavy gullies having been cut in places. Where the road has passed over rock all of the earth surfacing has been washed away. This is particularly noticeable in the descent to and ascent from Yosemite Creek, and in the descent to Lake Tenaiya. The road was also obstructed by fallen timber, which, in some instances, measured 6 feet in diameter.

It appears that no road work in the way of maintenance has been done by the owner of the road for a number of years, though some slight work has been done by campers traveling over it. The cost of construction of a like road at the present time may be summarized as follows: Of flat and slightly sloping ground there are 20 miles, which would average in cost $400 per mile. Of hillside rock, requiring cuts and fills, the removal of timber and small rocks, there are 33 miles, which would cost $1,200 per mile. Of rock work, the construction of retaining walls, and heavier cuts and fills, there are 2 miles, which

Sardine Lake and Mount Parker, from Mount Gibbs, on Line of Extension of Tioga Road.

Extension of Tioga Road Survey.

would cost $2,500 per mile, and of sea-wall around Lake Tenaiya there are 1.15 miles, which would cost $5,000 per mile, giving a total of $58,000 for the road.

It appears that in the early history of the road some tolls were collected. None, however, have been collected for a number of years past. The rates of toll are fixed by order of the Boards of Supervisors of Mariposa and Tuolumne counties, and are as follows:

From Crocker's Station, in Tuolumne County, to Tioga, in Mono County, a Distance of 56.15 Miles.

For freight team with two horses	$5 00
Each additional horse	1 50
Empty wagons, half rates.	
Passenger teams, each horse	2 50
Footmen	1 00
Horse and rider	2 00
Each pack animal	1 50
Loose horses and cattle	50
Sheep, hogs, and goats, each	10

And for a less distance than the whole thereof in such proportions of the whole amount of tolls allowed to be charged as the distance traveled bears to the whole distance of the road.

No attempt has been made to keep the road in order and suitable for travel since the closing of the Tioga Mine, in 1885. Were there an extension of this road to points of settlement to the east of Tioga, thus making the road a thoroughfare, the road would doubtless have been maintained open from June 15th to November 1st during ordinary seasons.

Under the provisions of the act looking to a new wagon road connecting this road with a road traveled by wagon in Mono or Inyo counties, your Commission inspected three possible routes, namely, the Mill Creek, the Levining Creek, and the Bloody Cañon, these being the only practicable routes, and they are presented in detail, as follows:

MILL CREEK CAÑON ROUTE

May be best divided into five sections, as follows:

Section 1, from the Tioga Road to Saddle Bag Lake.

Section 2, Saddle Bag Lake to head of Mill Creek Cañon.

Section 3, head of Mill Creek Cañon to beginning of Slide.

Section 4, Slide to foot of cañon.

Section 5, foot of cañon to road connection in Mono County.

Section 1 leaves the Tioga Road about a mile north of Tioga at an elevation of 9,900 feet, and ascends to an elevation of 10,300 feet. The country is rolling close to the foot of the mountains. The soil is of a micaceous granitic character, and exceedingly susceptible to wash. Somewhat expensive ditching for drainage of storm-waters would therefore be necessary to protect the roadway. The section would be about

2 miles in length, with an average grade of 6 per cent, varying from 2 to 8 per cent, and costing $1,500 per mile, or $3,000 for the section.

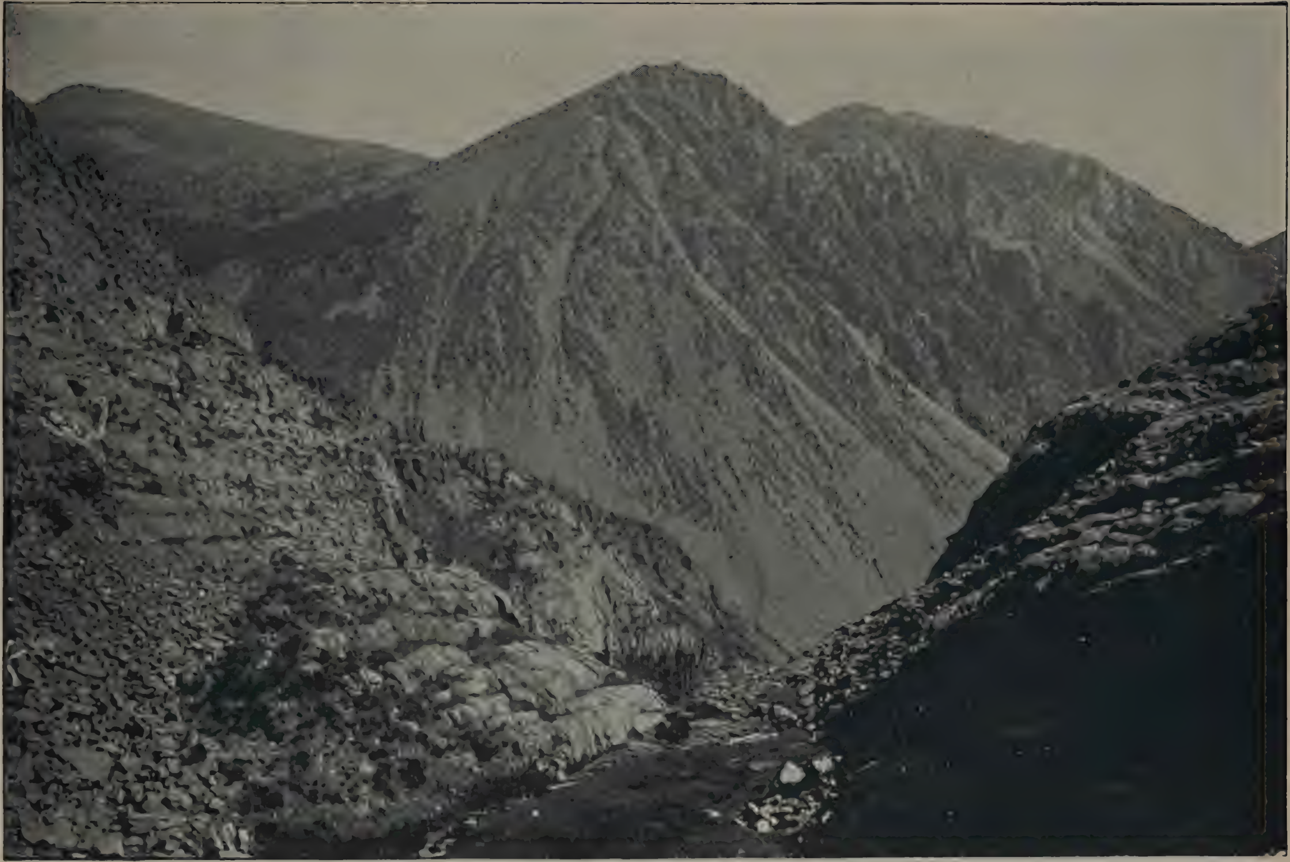
Section 2 ascends from 10,000 feet to 10,700 feet, passing around the eastern shore of Saddle Bag Lake and over the side of Mount Warren, the formation consisting of a soapy, slaty shingle, broken in flat pieces, and varying from the size of a saucer to three or four times that size, and of an inch in thickness. The side of the mountain standing at an angle of 45 degrees, the entire roadway would be of sidehill character, and would have to be supported by a retaining wall on the lower side, and likewise protected by a retaining wall on the upper side, supporting an enormous surcharged mass of this material. Without these walls it would be impossible to construct or maintain this section. The length of the section would be 4 miles. No average grade could well be established, the grades varying from zero to 10 per cent. The cost per mile would be at least $5,000, thus giving a total cost to the section of $20,000.

Section 3 is the most expensive portion of work on the entire route. Descending from an elevation of 10,500 feet to 9,700 feet, and passing for its entire length over solid rock, with an angle of at least 85 degrees, almost the entire length would have to be in gallery. The rock is of an igneous character and of exceedingly fine texture and tough, presenting great resistance to the action of explosives. The length of the section would be 1.5 miles, and an average grade of 10 per cent could be maintained over the entire distance, and the cost of construction would be at least $15,000 per mile, or $22,500.

Section 4 descends from 9,700 feet to 8,600 feet over a loose sliding shingle of even a worse character than that at Saddle Bag Lake, standing, as it does, at an angle of 60 degrees, which is barely more than the angle of repose, thus necessitating higher and more expensive retaining walls than those of that section. The length would be 2 miles, and the cost per mile $7,000, cost of the section being $14,000.

Section 5 descends from 8,600 feet to 8,000 feet over the floor of Mill Creek Cañon, which is rough and covered with large bowlders and dense brush and small trees. While not difficult of construction from an engineering standpoint, the work will be necessarily expensive. The length is 3 miles, and the cost per mile would be $1,500, the total cost of the section being $4,500, thus giving a total length to this route of 12.5 miles, and a total cost of $64,000.

It would also seem from personal observation, as well as from information gleaned from residents, that the snowfall in this cañon is of exceeding depth, and that, owing to its conformation, the action of the sun in melting the snow is much retarded, the result being that a road through this cañon would be closed to travel for a much longer period than those through either Levining or Bloody cañons; another disad-



Looking Down Levining Creek Cañon. Suggested as a Possible Route for Extension of Tioga Road.

vantage being that this route would be fully 10 miles longer from the eastern to the western side of the mountains than either of the other named routes.

LEVINING CREEK ROUTE.

This route may be divided into three sections, as follows:

Section 1, from a point on the Tioga Road, about 2 miles south of Tioga, to a small lake at the head of Levining Cañon.

Section 2, from the lake to the floor of Levining Cañon.

Section 3, from end of Section 2, along floor of cañon to road connection in Mono County.

The sections, in detail, are as follows:

Section 1 descends from an elevation of 10,000 feet to 9,500 feet, passing over earth with a few bowlders. Some small trees and underbrush would have to be removed. The length of the section would be about 2.25 miles, the average grade would be about 4.2 per cent, and in no case need the maximum grade exceed 5 per cent. The cost per mile for the section would be $600, giving a total cost for the section of $1,350.

Section 2, descending from 9,500 feet to 7,500 feet, and passing over talus and rock in place. The rock being of granitic formation, is easily worked by the use of modern explosives. But little drilling will be necessary to make the explosives effective. The rock shatters easily, and can in almost all cases be used for filling and "chinking" within a few feet of the point of removal. On account of the elevation to be overcome, it has seemed wise to reduce the grade by lengthening the section by means of "switchbacks"; this, therefore, makes the section 4.76 miles in length, and gives a grade of 8 per cent, which can be kept uniform throughout the length of the section. All things considered, this has seemed the economic grade to adopt for this section, for, while a less grade might be established, to do so would, perforce, lengthen the section and, in a like ratio, increase the cost of construction, with comparatively little benefit to travel. While to increase the grade would have decreased the mileage, and also the cost, it was not deemed wise, as a grade above 8 per cent is burdensome to travel. The width for the roadbed for the section should be 10 feet. This would accommodate all the travel on the road for years to come. The cost per mile for the section would be $5,000, thus giving for the section a total cost of $23,800.

Section 3 descends from an elevation of 7,500 feet to 7,200 feet, and follows along the floor of Levining Creek Cañon, the soil consisting of mold mixed with disintegrated granite. There are no difficulties to be encountered in the construction of this section, the principal work consisting in the clearing away of small aspen trees and underbrush, which could be used for mattress at one or two boggy places, which would have to be drained by short ditches emptying into Levining Creek. The length of the section would be about 3 miles, and the grade would average 2 per cent and vary from 1 to 4 per cent in places. The cost of construction is placed at $500 per mile, which gives a total cost for the section of $1,500.

This would give a total length to the road of 10.01 miles, and a total cost of $26,650, exclusive of engineering superintendence.

There are many points in favor of the Levining Creek route, notably, it is but 10,000 feet in elevation at its highest point, as against an elevation of 10,600 feet at Mono Pass on the Bloody Cañon route, and 10,700 feet between the Saddle Bag Lake and the head of Mill Creek Cañon, reached in the last-named route. This route also presents the least engineering difficulties, and here a roadway can be constructed for a less amount of money than by way of either of the other routes. It is the middle route between Mill Creek on the north and Bloody Cañon on the south. It also gives a much shorter line of communication between the Mono Lake Basin and its tributary territory on the east and the Great Central Valley of California on the west than the Mill Creek route, and fully as short as the Bloody Cañon route. It can also be kept free from snow for a longer portion of the year than either of the other routes.

BLOODY CANON ROUTE.

This route would best be divided into five sections, to wit:

Section 1, from the junction of the Lyell and Dana forks of the Tuolumne River to the crossing of the Dana Fork.

Section 2, from the crossing of Dana Fork to the head of Mono Pass.

Section 3, from the head of Mono Pass through the gorge of Bloody Cañon to the foot of the same.

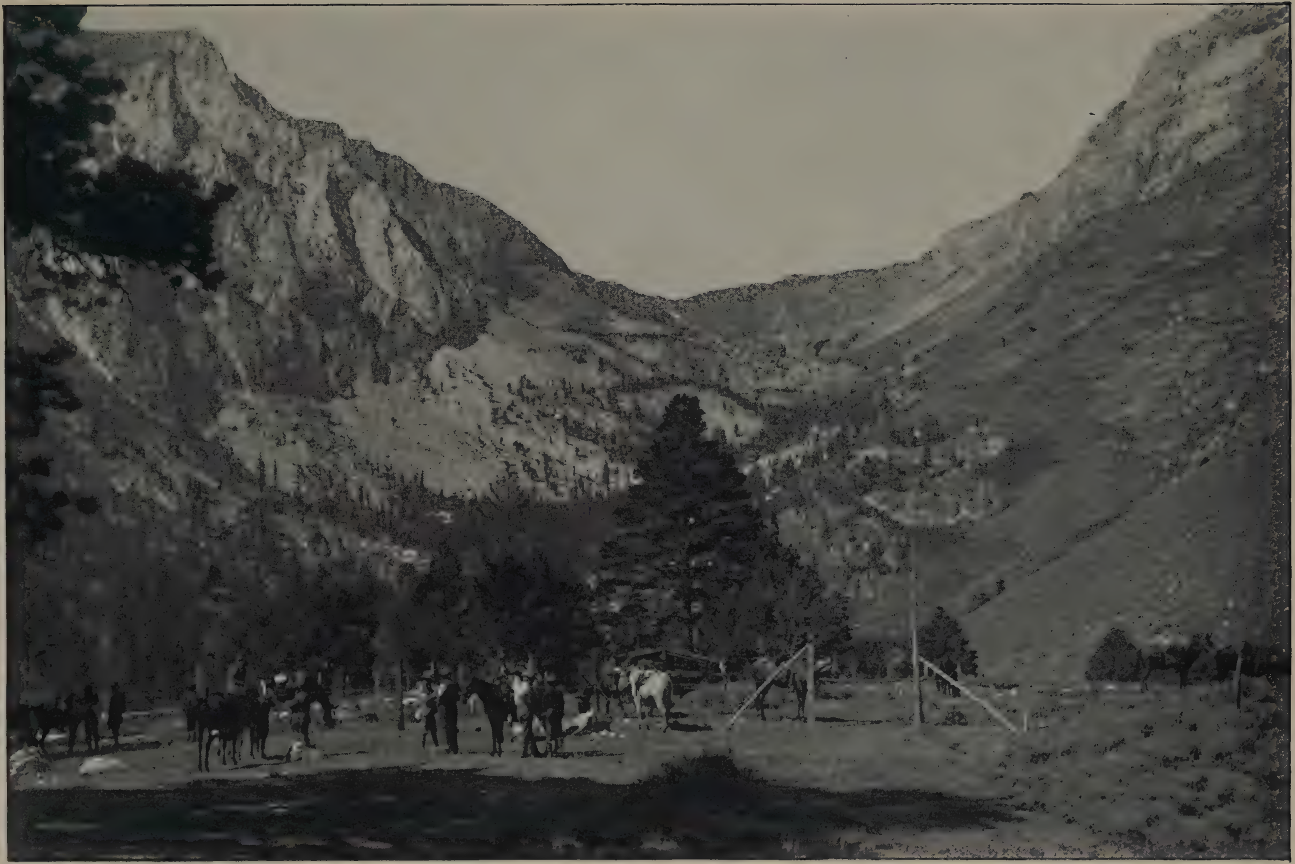
Section 4, from foot of Bloody Cañon gorge, along Saddle to floor of Bloody Cañon, near Walker Lake and boundary of Yosemite National Park.

Section 5, along the floor of Bloody Cañon to road connection in Mono County near Farrington's.

Section 1 ascends from an elevation of 8,594 feet at the initial point to 9,800 feet at the head of Mono Pass. The general character of the country is meadow land, interspersed with bowlders and trees, there being but little brush; the distance being 6 miles; the grade averaging 4 per cent, and varying from 1 to 6 per cent. The cost of construction would be $800 a mile, giving a total cost of $4,800 for the section.

Section 2 is of the same general character of soil as Section 1. There are, however, less trees and more rock. The roadway here ascends from 9,800 to 10,600 feet, the section being 3 miles in length. The grade would average 5.5 per cent, and vary from 2 to 8 per cent, the cost of construction being $1,000 a mile, a total for the section of $3,000.

Section 3 presents the greatest engineering difficulties, and is the most expensive of the route, descending from an elevation of 10,600 feet



Foot of Bloody Cañon, at Head of Walker Lake.

to 9,000 feet, and passing over and around bluffs precipitous in character and of a granitic character, bordering in places to trap and porphyry. The use of considerable quantities of explosives would be necessary; the rock is, however, of a character not unusually difficult to work. The lower portion of the roadway passes over talus that could be broken by hammer and moved by crowbars. The length of the section would be about 3.02 miles, and the most feasible grade would seem to be 10 per cent, which could be kept uniform for the entire distance. There should be turnouts at every thousand feet, and by their use the width of the roadway could be kept down to 10 feet. The cost would be $7,000 a mile, or $21,140 for the section.

Section 4 descends from an elevation of 9,000 feet to 7,900 feet, carries the roadway along the hillside and through earth, with but few loose rocks and small timber in the way. The length of the section would be 3.5 miles, with an average and uniform grade of 6 per cent, the cost of construction being $1,500 per mile, or $5,250 for the section.

Section 5 runs along the floor of the cañon, descending from 7,900 feet to 7,400 feet, the entire distance being over good earth, with some underbrush to remove. The section would be 2 miles long, and have an average grade of 5 per cent, the cost of construction being $500 per mile, or $1,000 for the section.

This would give a total length for the route of 17.7 miles, and a total cost of $35,190.

WAGON ROAD TO HETCH HETCHY VALLEY.

Leaving the Big Oak Flat Road at Hodgden's, a park road was followed to the South Fork of the Tuolumne River. Here junction is made with the Tioga Road, which we traveled to the top of a hill, a distance of 1.25 miles; thence by a private road through Carlin's ranch to the middle fork of the Tuolumne River, and thence over a park road to the Hog Ranch. This distance, by already existing road, is 7.18 miles, as just described. From this point on to the Hetch Hetchy no road exists, and a location for a proposed roadway was viewed.

It can best be divided into three sections, as follows:

Section 1, from the Hog Ranch to a point a mile north of the cañon.

Section 2, from end of Section 1 to a flat 600 feet above the southwest corner of Hetch Hetchy Valley.

Section 3, from end of Section 2 to floor of Hetch Hetchy Valley.

The sections in detail are as follows:

Section 1. Leaving the Hog Ranch at an altitude of 4,736 feet, the roadway gradually ascends to an elevation of 5,500 feet at the end of the section, the roadway traveling a somewhat rolling country, with but little rock and some trees of small size, the section being entirely in earth. The distance is 6 miles, and would give a grade varying from

1 to 5 per cent, and can be constructed for $1,200 per mile, or $7,200 for the section. This would include the cost of drainage and culverts.

Section 2 descends from 5,500 feet to 4,100 feet, a distance of 1,400 feet in elevation. The major portion of the way is over solid rock of a granitic character, which is somewhat decomposed and easy to work. Portions of the roadway would be along the face of bluffs standing at angles of from 45 to 80 degrees, while at other places long benches exist which could be utilized in the final location. There would be many heavy cuts, and in other places fills with retaining walls would be necessary. The length of the section would be about 6 miles. No uniform grade could be established, but in no case would it be necessary to have a grade in excess of 10 per cent, though in order to accomplish this many switchbacks would have to be made use of. The cost per mile for labor and tools, materials and explosives, in this section would average $6,000, or $36,000 for the section.

Section 3 descends from 4,100 feet to 3,660 feet, passing over solid rock standing at an angle of 80 degrees, and detritus, requiring numerous switchbacks. The major portion of the detritus would have to be supported by a heavy retaining wall. The length being 1.5 miles, grade could be kept uniform at 5.5 per cent, the cost averaging the same as the previous section, $6,000 per mile, or $9,000 for the section.

Thus giving a total length of new road of 13.5 miles, and a total cost of $52,200.

A road into Hetch Hetchy Valley having been constructed along this route, connection could then be made with the railroad system of the State by running a road out over the northern side of the Hetch Hetchy Valley, thence to McGill's Meadows, and from there to Carters, an approximate distance of about 25 miles, which is the projected terminus of a narrow-gauge railroad now in process of construction by the West Side Flume and Lumber Company. The latter road begins at Chinese Camp, where connection is made with the Sierra Railway, which ultimately makes connection with the Southern Pacific and Santa Fé systems in the San Joaquin Valley.

TENAIYA CANON ROUTE

Can best be divided into seven sections, as follows:

Section 1, leaving the Tioga Road at the western end of Lake Tenaiya and extending to the head of the first falls on Tenaiya Creek.

Section 2, from head of falls to flat.

Section 3, through flat to head of second falls.

Section 4, falls to second flat.

Section 5, through second flat to head of Cascades.

Section 6, through Cascades to Yosemite Valley.

Section 7, from end of Section 6 to Mirror Lake.

The sections, in detail, are as follows:

Section 1. Leaving Lake Tenaiya at an elevation of 8,200 feet, and following the outlet of the lake, or Tenaiya Creek, the grade is a descending one until an elevation of 8,000 feet is reached at the head of Yale Falls. The roadway through this section would pass over a meadow with a gentle slope to the west, with enough coniferous trees of moderate size to make a pleasing shade. But few bowlders are encountered. The major portion of work on this section would be the "turnpiking" and ditching of the roadway, which could be easily done with a plow and road machine. The length of the section would be 1.75 miles. A grade could be obtained varying from zero to 3 per cent, and the cost of construction would not exceed $500 per mile for a first-class roadway of 16 feet in width, exclusive of ditches. This cost would also include culverts for drainage, which would not need to be placed at some few points, and should be made of a good vitrified pipe, and at different points vary in size from 6 to 10 inches. The cost of the section would be $1,050.

Section 2. Descending from 8,000 feet to 7,700 feet. At this place Tenaiya Creek flows over solid granite of exceeding smoothness, in fact glacially polished, and the cañon becomes a gorge, of no great depth, however. Nor is the incline of the sides so great that one cannot walk over them by the exercise of due caution, their angle probably averaging 20 to 25 degrees. The roadway at this point would be of sidehill character. The rock cut from the uphill portion could be utilized for retaining walls and fill on the lower or downhill side. These retaining walls are easy of construction, and should be made of dry rubble. On this section the roadway width should be contracted to 10 feet, with two turnouts for the section. This section, properly constructed, should not need repairs for a century. The length of the section would be 1.42 miles; this length being necessary to obtain the proper grade, the air-length line of the section being probably not over 1,000 feet. The above-mentioned length having been given to the section, the grade could be established at 8 per cent and kept uniform for the entire length of the section. The cost per mile of this section can be best summarized as follows: Blasting and moving rock from cut to fill, 80 cents per yard; building retaining wall and parapet on lower side of roadway—both wall and parapet to be of dry rubble—20 cents per linear foot, as the cut would equal the fill, and the yardage would be about 2,500 yards, or cost $2,000 per mile, and with 5,280 feet of retaining and parapet wall at $1,056 would give a cost of $3,056 per mile. If it were thought more advantageous to do so, the retaining and parapet wall could be laid in lime or cement mortar, increasing the cost from $1,000 per mile for the former and $1,250 for the latter-named material. The cost for this section may therefore be placed at $4,339.50 for dry rubble walls.

Section 3 descends from an elevation of 7,700 feet to 7,300 feet, follows over the floor of a small valley presenting no engineering features of note, the main work consisting in the removal of bowlders and trees. The length of the section would be 1.25 miles, and the grade average 5.5 per cent. The cost per mile would be $1,000, making a total cost of $1,250 for the section.

Section 4 is the one presenting the greatest difficulties, and the one that would consume the major portion of the money necessary for the construction of the road. Beginning at an elevation of 7,300 feet at the head of the falls, to the foot of the falls in a horizontal line is a little less than 1,000 feet, while the vertical drop at this point is 1,500 feet, or to an elevation of 5,800 feet. Up to this point the proposed roadway would follow the course of Tenaiya Creek. Here the creek would have to be abandoned and a tunnel run in a northeasterly direction for a distance of 600 feet; thence, bearing more to the west, a gallery would run for a distance of 800 feet, from where the roadway would be a heavy cut and fill over solid rock and talus for a distance of 1,200 feet; thence by gallery and short tunnels for a distance of 4,500 feet to the talus, from whence a distance of 5,300 feet would take the roadway to the floor of the second flat, giving a total length of 12,400 feet, or 2.34 miles. This is for an average grade of 12 per cent, which should be sustained for the entire distance. The width of roadway on this section should, of course, be minimized to save expense, but in no case should the roadway be reduced to less than 8 feet in the clear. Turnouts, etc., should also be provided at proper distances.

The cost in detail would be:

600 ft. tunnel, at $5 per yard (3.15 cubic yards per foot)	$9,450
5,300 ft. gallery, at $3 per yard (2 cubic yards per foot)	30,600
12,200 ft. sidehill, at $2 per linear foot	2,400
5,300 ft. talus, at $1 per linear foot	5,300
Total for section	$47,750

Section 5 follows the floor of the second flat from an elevation of 5,800 feet to 5,300 feet, thus descending 500 feet in a mile and a half, giving a grade of about 6 per cent. The country presenting no difficult features, other than the clearing of trees, brush, and rock, the cost would be $2,000 per mile, or $3,000 for the section.

Section 6 again comes to falls, descending from 5,300 feet to 4,800 feet. There are no engineering features to the section, though the character of the rock work would be expensive, there being many heavy cuts and fills in the section. The length would be about 1.25 miles, the grade varying from 6 per cent to 10 per cent; the cost per mile would be $7,500, or $9,375 for the section.

Section 7 descends from 4,800 feet to 4,100 feet at Mirror Lake, in the Yosemite Valley. The upper two thirds of the distance is over rough talus, with a heavy growth of brush, the length being about 4 miles, the grade varying from 2 per cent to 8 per cent, the average cost per mile being $4,000, or $16,000 for the section.

Giving a total cost of $82,764 and a length of 14.51 miles for the entire road.

NEW WAGON ROAD FROM YOSEMITE VALLEY TO SUITABLE POINTS IN MERCED, MARIPOSA, AND TUOLUMNE COUNTIES.

We present for consideration a road along the Merced River as fulfilling the conditions of a best attainable new route from the Yosemite Valley to the several points mentioned. Such a road would afford the most direct and easy connection with Merced County at Merced Falls, and at Benton Mills on the river connection would be established with the existing road system of Mariposa County, and give a better connection with the railroad in Tuolumne County than is possessed by any of the existing roads, or could be had by any other practicable new road, and we submit the following in relation thereto:

A road along the cañon of the Merced River from the boundary of the Yosemite Valley at the Cascades, to Merced Falls, should, for constructional purposes, be divided into eleven sections, as follows:

Section 1, from the Cascades to Grouse Creek, a distance of 2.75 miles.
Section 2, from Grouse Creek to Indian Creek, a distance of 3.25 miles.
Section 3, Indian Creek to Hennessy's, a distance of 2 miles.
Section 4, Hennessy's to Ned's Gulch, a distance of 8.75 miles.
Section 5, Ned's Gulch to Filiscana Creek, a distance of 4.25 miles.
Section 6, Filiscana Creek to Colorado Gulch, a distance of 4.75 miles.
Section 7, Colorado Gulch to McCabe's Flat, a distance of 3.25 miles.
Section 8, McCabe's Gulch to Sherlock Gulch, a distance of 4 miles.
Section 9, Sherlock Gulch to Split Rock, a distance of 7.50 miles.
Section 10, Split Rock to Jones Flat, a distance of 15.25 miles.
Section 11, Jones Flat to Merced Falls, a distance of 6.25 miles.

Work on these sections may be divided into three sections:

First—Rock work, embracing the removal of large bowlders and certain jutting promontories of rock in place; the construction of heavy retaining walls and some rock "cuts and fills." The cost of this work would vary at different points, but would average $7,000 per mile.

Second—Sidehill work, where the cuts and fills would be largely in earth, with slight rock work and some timber, the cuts as a general thing equaling the fills, and at many points a slight retaining wall being a necessity, which would cost $1,800 per mile.

Third—Earth work, which would cost $700 per mile. Under this classification, the road generally follows along level and gently sloping ground, and presents but few obstacles, these mainly in the way of bowlders, small timber, and underbrush, which would of necessity have to be removed.

To the first class of work properly belong Sections 2 and 5, making a total length of 7.50 miles, or a total cost of $52,500.

The second class embraces Sections 4, 6, 8, and 9, with a total length of 25 miles, a fair estimate of cost being $45,000.

The third class embraces Sections 1, 3, 7, 10, and 11, a total distance of 29.50 miles, at a cost of $20,650.

Making a total cost of the road, $118,150.

In addition to this, however, is bridge work, which would also include the large culverts, the small culverts being included in the road work proper. For the bridge work just mentioned, a conservative estimate would be $15,000, which would construct stone arches of great permanence wherever necessary. This all being exclusive of engineering or superintendence, which would amount to about 2.5 per cent of the cost, giving a grand total for the road completed of $136,478.75.

From the initial point, Merced Falls, with an elevation of 360 feet, to the crossing of the South Fork of the Merced River, in Section 4, the grade would vary from zero to 3 per cent, the latter being the maximum grade necessary at any point, and that only for short distances. From this point to Hennessy's the grade would increase, at times running as high as 5 per cent, which would be the maximum. From here to the Cascades the rise is much more abrupt, and at places a grade of 10 per cent would be attained. It should be noted, however, that by far the major portion of the road is but little in excess of 1 per cent, only some 4 or 5 miles having higher grades, so that it would be well within reason to expect ordinary teams to travel the greater portion of this road at a speed of 8 miles per hour, thus giving access to the Yosemite Valley in a day.

A fact worthy of note on the Merced River Cañon route is that many roads now go within a mile of the cañon of the river, and were the road built along its course these roads would soon be extended to connection with it, thus giving access to the Yosemite Valley from the north and south as well as from the west. In addition, this would afford access to the valley at all seasons of the year.

While it may be argued that the cañon of the Merced is not an all-winter route, yet we think this fact is best demonstrated by Nature, in that the Commission saw specimens of flora that exist only in semi-tropical climate, and ate fresh figs from trees growing along the cañon, even at its upper end, and within a few miles of the valley, the fig tree being one peculiarly susceptible to cold, a temperature below freezing killing it.

One of the main difficulties that has been experienced with the other roads has been dust, and a lack of good water and shade. This proposed road, following as it does the meanderings of the Merced River, could be sprinkled from end to end at a minimum cost. With proper grade small ditches could be laid out along the side of the road, water could be readily turned into them from the river, and along their edges could be planted suitable deciduous trees, which in a short time would grow to sufficient size to give a pleasing shade to the roadway during the heat of summer, and in the winter, free from their leaves, would permit the sun to play upon the surface of the roadway and evaporate moisture.

* * * * * * * *

CONCLUSION.

The Yosemite Valley was first seen by the whites in 1851, but its existence was not generally known until the latter part of the fifties, when people commenced to visit it in increasing numbers. About 1865 the wonders of the valley had attracted sufficient attention to cause it to be set apart as a public park by an Act of Congress. Until 1874, however, access could only be had to it by trails. As early as 1869 a wagon road was projected into the valley; the work of construction on this road, however, proceeded but slowly. With the inception of this road, a natural rivalry between those sections over which previous travel had gone to the valley by trail was stimulated to such a degree that two other roads were projected, and the construction undertaken, so that the year 1874 saw three roads building to the valley, each one striving to be the first to reach it. They were the Wawona Road, the Big Oak Flat Road, and the Coulterville Road. Unfortunately, in the location of these roads, all of them followed routes for the convenience of settlers living in the high Sierras, and not direct routes from the plains of the San Joaquin Valley to the Yosemite Valley. It is worthy of note that all of these were built by private interests, as investments, from which to secure good returns. It may also be noted that they give access to the Park only from the south and west, and that there are no roads from the north and east.

All these roads reach high altitudes, and are subject to interruption to travel by reason of heavy snowfalls during a large portion of the year. In winter a great many tourists come to the Pacific Coast, and they are debarred the pleasure of visiting the valley when its great natural beauties are enhanced by the winter snows, because at this period of the year the roads now used are generally impassable. It is believed that a road through the Merced Cañon would be an all-winter route.

So far, the Federal Government has done nothing in the way of road-building, or acquiring of roads already built, in or about the Yosemite Park. The State, however, has at various times purchased and made free the roads and trails laid out within the boundaries of the Yosemite Valley grant.

Up to 1890, but little attention had been paid to the country surrounding the Yosemite Valley. In that year Congress set aside certain lands situated in the high Sierras as a park for the people, naming it the Yosemite National Park. It may truly be said of this park that it has but one rival, and no superior, in scenic interest in the world, if even the Yellowstone Park may be considered a rival. In addition to the Yosemite Valley, now so well known, are other valleys of perhaps less magnitude, but equal grandeur—the Hetch Hetchy, the Grand Cañon of the Tuolumne, the Grand Cañon of the Tenaiya, and others, all within the National Reserve.

Situated as is this park in the main range of the Sierra Nevadas, its altitude varies from 3,000 to 13,000 feet. Peaks capped with perpetual snow are numerous; Mount Conness, Mount Hoffman, Mount Gibbs, and many others raise their heads to an elevation in excess of 12,000 feet, while Mount Lyell, Mount McClure, and Mount Dana have living glaciers of great beauty, equal in interest to those of Switzerland.

At the present time, although this is a public park, an embargo has been laid upon travel, in that all who wish to visit it must pay tribute in the way of tolls to the owners of the roads. It would appear that if the park is a free one for the people, access to it should also be free. This can be accomplished by the Government, and it would seem to be its duty either to purchase the existing roads or to construct new roads. It would not appear, however, to be just for the Government to construct a new road without making compensation for the existing roads, in that the construction of a new road, free of tolls, would mean the diversion of all the travel from the toll-roads to the free-road, which would be practically a confiscation of the toll-roads. In addition to this, it would appear exceedingly advantageous for the Government to own all the roads within the park, for in this way only can entry into the park be controlled.

Moreover, the lands within the Yosemite National Park having been exempted from entry, the value of the toll-roads has been depreciated, and through no fault of their owners; and inasmuch as this large area has been withdrawn from settlement or utilization in any manner save as a park, it would be only right that it be made a park in fact as well as in name.

Furthermore, while the existing roads are necessary for patrolling the park by the troops guarding it, still the means of communication are extremely inadequate.

Again, the cost of transportation of supplies to the troops, now carried on by means of pack trains, could be lessened to a great extent, and fires, which are a constant menace to the park, could be more readily extinguished were additional roads built, and the Secretary of the Interior would have better means to carry out the regulations for the government of the park.

By making free all of these existing roads, and the construction of new ones as suggested, all portions of the park could be easily reached. Following along the Tioga Road a series of lakes and streams are passed that are unequaled for fishing. The scenery is particularly grand, and there are found here a number of mineral springs which are equal to any of the famed springs of the country.

From Tuolumne Soda Springs on the Tioga Road, a road could be built along the Lyell Fork of the Tuolumne River, and reach the foot of the Lyell Glacier in the distance of 7 miles, at a cost probably not exceeding $4,000. Through this section of the park, wood, water, and grass abound, making it a paradise for campers.

The importance of a thoroughfare across the Sierra Nevada Mountains, in this region, can hardly be emphasized too strongly. Communication from the Mono Valley can be made with the Tioga Road by either of the three passes described. From Lake Tenaiya, on this road, the route would follow Tenaiya Cañon to the floor of the Yosemite Valley; thence utilizing the road already existing in the valley to the Cascades, the route could be taken down the Merced River, giving a distance from the Mono Valley on the east to the San Joaquin on the west of practically 115 miles. The necessity of this route can be more readily seen when it is stated that there are no existing roads crossing the mountains nearer than 200 miles on the south and 125 miles on the north. With such a road communication could be had between the two valleys for probably seven months of the year, while the advantages of this road for reaching the Yosemite Valley by way of the cañon of the Merced River would be an easier and more speedy trip than can be had over any of the existing routes, and this portion of the route will remain open to travel through the entire year.

A road in Tenaiya Cañon would pass through a valley only surpassed by the Yosemite in size, and only equaled by it in its ruggedness. Such a road would shorten the distance between the valley and Soda Springs more than 50 miles, and avoid the altitude reached on the Tioga Road at Snow Flat, which makes travel by that route possible for but a short season, by reason of the heavy snowfall. The magnificent cliffs and waterfalls of this cañon would alone warrant the construction of the road.

The route over the floor of the Yosemite Valley is so well known that we pass to the Cascades, the beginning of the Merced Cañon portion of the route. From here the road follows the meanderings of the Merced River at its upper portion, passing cliffs, waterfalls, and cascades of great beauty, a fitting scenic preamble to the greater magnificence of the valley itself.

Glimpses are had of the old life of California, in the way of decaying cabins and abandoned mines, yet still the tourist may see the mining industry carried on there in all its stages, from the crude rocker and arrastra to the modern quartz-mill.

The lower portion of the cañon passes orchards and vineyards, many in a high state of cultivation, and finely debouches upon the plains of the San Joaquin at Merced Falls.

Respectfully,

S. M. MANSFIELD,
Colonel, Corps of Engineers, U. S. A.,

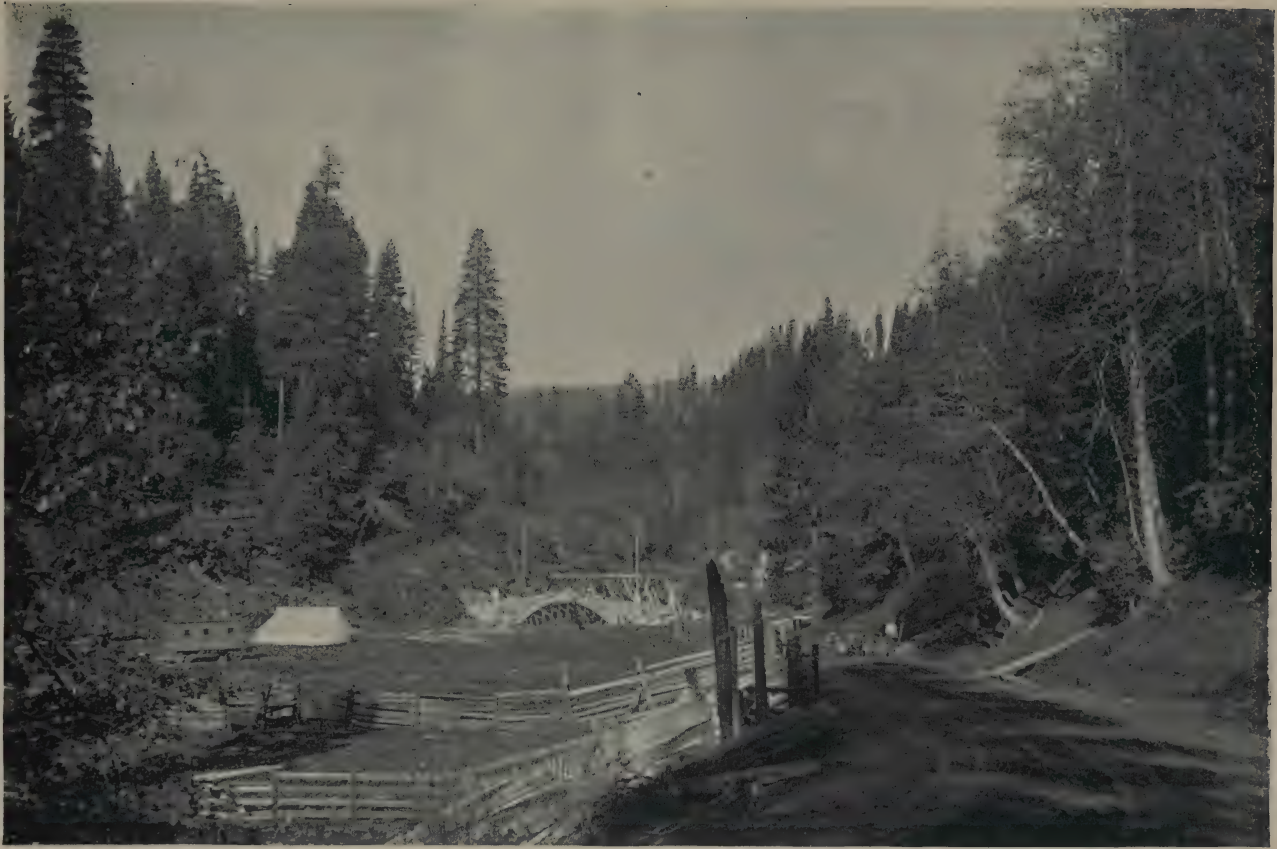
HARRY C. BENSON,
Captain, Fourth Cavalry, U. S. A.,

J. L. MAUDE,
Department of Highways, State of California,

Commissioners.

To the Secretary of the Interior, *Washington, D. C.*

Riverton, on the Lake Tahoe State Highway.



Lake Tahoe State Highway; Easterly Approach to Stone Bridge at Riverton.

APPENDIX B.

REPORT OF THE LAKE TAHOE STATE WAGON ROAD COMMISSIONER.

MARCO VAROZZA, COMMISSIONER.

PLACERVILLE, CAL., November 1, 1900.

To His Excellency HENRY T. GAGE, *Governor of the State of California:*

SIR: I have the honor to submit the following report on the Lake Tahoe State Wagon Road, originally established under the provisions of an Act of the Legislature of the State of California, approved April 1, 1897 (Chapter CCXLV, Statutes of 1897), which said Act was amended by an Act approved March 28, 1899 (Chapter CCLIII, Statutes of 1899), under which amendment the State Highway Commissioner was charged with the supervision of necessary plans, surveys, and specifications for contemplated work in connection with said Lake Tahoe State Wagon Road.

Under Section 2 of the last-mentioned Act, the following appropriations were provided for:

(1) Immediately available, for paying salary, traveling and other expenses incurred by the Lake Tahoe State Wagon Road Commissioner, and to pay for making of surveys, plans, and specifications by the State Highway Commissioner, the sum of $5,000.

(2) For repairing and improving said road and the structures thereon, and the building of any new necessary structures thereon, the sum of $20,000, available from and after January 1, 1900.

The Lake Tahoe Wagon Road, which is entirely situated in El Dorado County, commencing at the junction of the Newtown and Placerville roads, a short distance easterly from Smith's Flat, has its terminus at a point on the east boundary line of the State of California, at or near Lake Tahoe, traversing about 58 miles of mountainous country. Owing to the character of the country traversed, a great amount of repair work is found to be necessary to keep the road open to travel, and it has been the intention of your Commissioner to make all improvements as lasting as possible.

The following is a summary of work carried on by your Commissioner, under the superintendence and with the advice of the State Department of Highways:

Between Smith's Flat and the Five-Mile House (a distance of 2 miles) four old wooden culverts were replaced by stone structures, and considerable grading of the road was accomplished. In the work of grading this part of the road a bank of lava was uncovered and used for surfacing in this locality. From the Five-Mile House to the Fourteen-Mile House, the same nature of work was continued, viz: grading and placing of stone culverts. A wooden bridge, with dry masonry walls, was built at the bottom of the grade west of Fresh Pond, and to the east of Fresh Pond, where considerable caving of the road had occurred, a large fill was found necessary to be made.

Near the Pacific House, a wooden bridge, with dry masonry wall, 15 feet in length, together with the necessary culverts, was constructed, and a fill and retaining wall, 50 feet long and 12 feet high, were constructed in this locality, formerly the site of an old sawmill, which had been washed out.

Continuing work to Maple Grove, half a mile below Riverton, general repairs and grading were attended to, and bridges and culverts constructed.

At Riverton, where the road crosses the South Fork of the American River, it was found absolutely necessary to replace the existing old combination truss bridge with a more permanent structure. This bridge has been, for a number of years, in an unsafe condition, and has been threatened with a breakdown at any time when an ordinary heavily loaded wagon passed over it. Owing to the natural abundance of a fine quality of granite in the vicinity, and the necessity for a durable and strong structure at this point, it was decided, with the advice of the Commissioner of the Department of Highways, to erect a stone arch. A location immediately adjoining the old bridge was decided upon as affording the best foundation for such a structure; and plans and specifications were, therefore, prepared by the Department of Highways, for an 81-foot span, bids advertised for and received, and contract let to Messrs. Clark & Henery, of Stockton, as being the most favorable bidders. Work was commenced on the bridge about the beginning of June of this year, thorough inspection being made of the work during all stages of its progress. The false-work was removed from the arch on November 12, 1900, proving the solidity of the structure, which is now open for travel.

From this bridge upward, in an easterly direction along the road, general grading and repairs have been attended to, turnouts have been established, side-ditches cleaned out and repaired, and culverts replaced and constructed.

About 2½ miles below Georgetown Junction, where the road leading over to Placer County is met, a fill and retaining wall were made, 65

Lake Tahoe and Placerville State Highway, Showing Heavy Retaining Wall.

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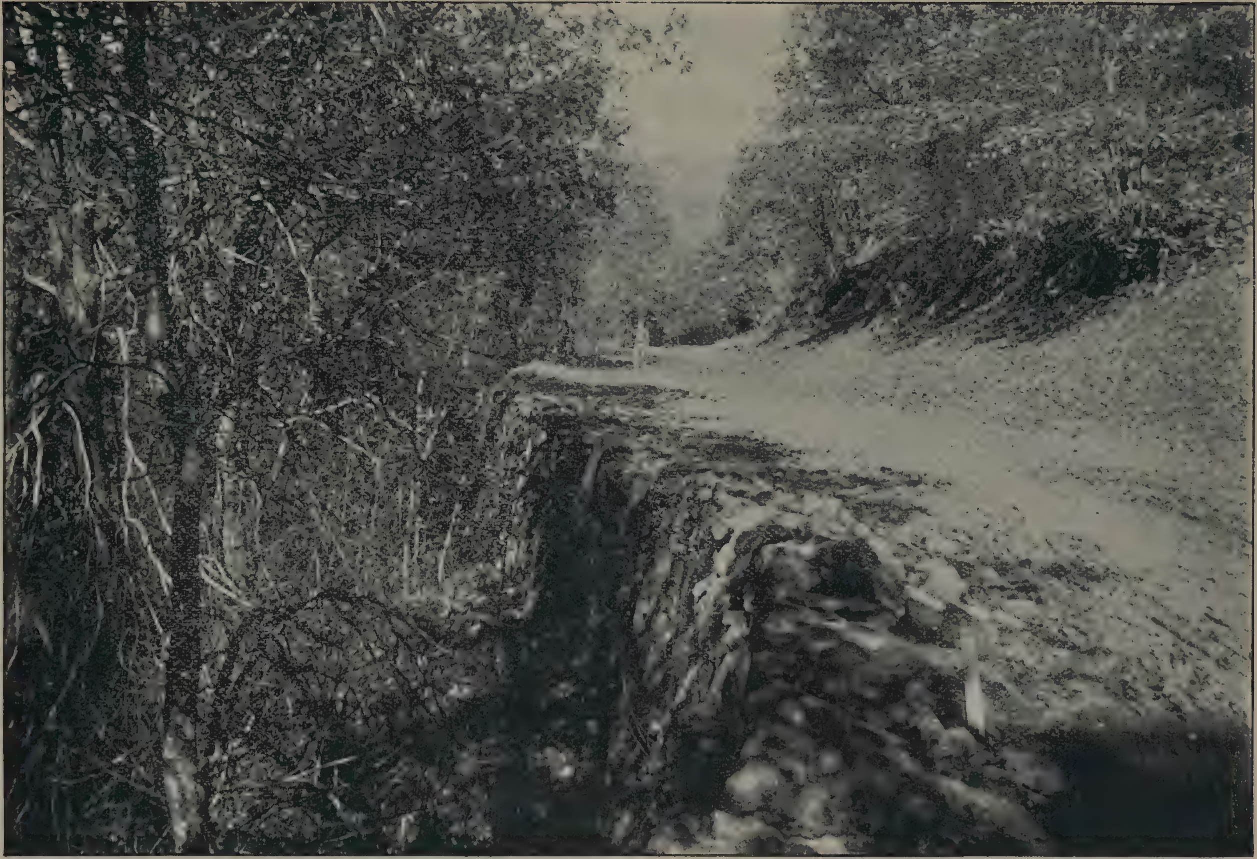

Lake Tahoe State Highway, Showing Retaining Wall.

feet long and averaging 20 feet high, the material comprising the same being granite obtained near by.

A mile and a half west of Georgetown Junction, it was found advisable to widen the road, and this work was accomplished, and provision made to guard against the tendency of the road to wash.

Continuing to Strawberry, general repairs and maintenance were attended to, a 20-foot wooden bridge being erected 3 miles west of Strawberry, taking the place of an old fill, which has been washing out continually from year to year, owing to heavy storm-waters in this vicinity. The road was widened and stone retaining walls erected.

From Strawberry up the Slippery Ford Hill, all bowlders were removed, blasting being done where necessary, and a surfacing laid up the hill of cedar bark, covered with six or seven inches of dirt. Two stone culverts were placed in this vicinity; and it has been found by your Commissioner that these improvements have been approved of by the general traveling public on the road.

Beyond this point, and as far as the western terminus of the road, general repairs of the road have been attended to.

It is the opinion of your Commissioner that this road is in much better condition at the present time than it has been for a number of years, although there is a great deal of opportunity for further improvement, which can only be accomplished by further appropriations to enable the work of maintenance of the road to be continued, with the end in view of placing in position permanent structures, in the way of masonry retaining walls, stone and vitrified pipe culverts, and durable bridges, so that the cost of maintenance may be gradually lessened. Under the advice of the Commissioner of the Department of Highways, about 800 feet of vitrified pipe has been purchased, the same ranging in size from 4 to 16 inches, to be used in the construction of culverts along the highway.

This great interstate highway, if properly maintained, is of great benefit to California and Nevada, as well as affording unlimited pleasure to the thousands of pleasure-seekers and tourists who annually visit the beautiful lakes and streams of the lofty Sierras. While the fund for its actual maintenance, which is contained in the General Appropriation, is generally adequate, it will be absolutely necessary to replace a large number of the old culverts and drainways along the road with new and permanent structures, as well as to repair many of the old bridges along the highway, and this will require a further substantial appropriation. The heavy winter storm-waters make it necessary that these should be of a substantial character, and, unless this work can be accomplished, there is great danger of large washouts occurring at various points along the road.

The re-surveying of the road by the engineering force of the Department of Highways has been commenced, and, this work coming immediately under the supervision of Mr. Maude, I presume that he will report on the same.

In closing this report, I desire to extend to your office thanks for the kind interest manifested in relation to the road, and I also wish to express my thanks to Hon. J. L. Maude, Commissioner of Highways, for his ready assistance in all matters in connection with our joint duties on the road.

Respectfully submitted.

MARCO VAROZZA,
Commissioner.

FINANCIAL REPORT OF COMMISSIONER OF LAKE TAHOE STATE ROAD.

1899		
Mar. 31—	Chas. Sandfoss	$1 25
	J. H. Zimmerman	3 25
	Wm. Martin	6 00
	Joseph Waring	9 00
	M. Varozza, Comm'r	9 65
	H. Phelps	32 00
	Susie Stewart	1 75
	Susie Stewart	5 00
	Thos. Alderson	9 75
	Mary L. Papina	50
	Sunset Telephone Co.	2 20
	M. Ryan	60 00
	E. Jones	32 00
	M. Simone	22 00
	F. Phelps	10 00
	H. Phelps	10 00
	M. Ryan	62 50
	Ed Jones	30 00
	M. Simone	20 00
	Frank Phelps	24 00
	Ed Jones	24 00
	M. Simone	16 00
	Frank Phelps	34 00
	Harry Phelps	32 00
	Ed Jones	16 00
	Geo. Blakeley	12 00
	Frank Phelps	20 00
	Frank Phelps	16 00
	Antone Berry	20 00
May 31—	F. R. Stephens	10 00
	J. H. Zimmerman	4 00
	Chas. Sandfoss	4 00
	R. L. Weibught	2 50
	Peter Millbrook	2 00
	George Marquini	76 50
	Harry Phelps	12 00
	J. De Bernardi	106 00
	M. Varozza	33 00
	Thos. Alderson	37 94
	Rico Varozza	101 50
	P. Michalitti	63 75
1899		
May 31—	R. Varozza	$63 75
	V. Campini	61 25
	A. Bon	49 00
	M. Simone	49 00
	Dan G. Carr	50 00
	J. Beffa	20 00
	Frank Phelps	50 00
	Harry Phelps	46 00
	E. F. Walsh	48 00
	Ed Jones	36 00
	Frank Phelps	50 00
	Harry Phelps	40 00
	J. De Bernardi	108 00
	Geo. Marquini	69 00
	M. Varozza	36 00
	Thos. Alderson	25 00
	Harry Phelps	96 00
	J. Zimmerman	3 50
	Lou Pratt	2 50
	Wm. Martin	3 00
	Chas. Sandfoss	2 50
	Mountain Democrat	2 50
	A. J. Selio	2 00
	M. Varozza	1 85
	R. Varozza	105 00
	P. Varozza	60 00
	P. Michalitti	67 50
	A. Bon	52 00
	M. Simone	52 00
	V. Campini	40 00
	Frank Phelps	52 00
	Harry Phelps	2 00
	E. F. Walsh	26 00
	Dan G. Carr	44 00
	D. E. Cappi	34 00
	M. Ryan	62 50
	M. Ryan	12 50
	M. Ryan	42 50
Oct. 30—	M. Varozza	10 00
	M. Varozza	5 00
	M. Varozza	10 00

FINANCIAL REPORT—LAKE TAHOE STATE ROAD—Continued.

1899		
Oct. 30—	Francis Frey	$78 00
	M. Varozza	22 00
	Francis Frey	81 00
	Sunset Telephone Co.	1 00
	Chas. Sandfoss	5 00
	M. Varozza	50
	D. E. Copple	22 50
	Harry Phelps	10 00
	D. E. Copple	20 00
	Harry Phelps	10 00
	Alex Cowen	6 00
	D. E. Copple	20 00
	Rico Varozza	65 00
	Will Frey	52 00
	D. E. Copple	10 00
	Harry Phelps	8 00
	Ed Jones	30 00
	M. Ryan	20 00
	R. Varozza	67 50
1900	Will Frey	54 00
Apr. 11—	J. C. Stevens	9 00
	James Davis	5 00
	Francis Frey	3 00
	J. H. Zimmerman	3 00
	Henshaw, Buckley & Co.	325 00
	Southern Pacific Co.	14 19
	Sunset Telephone Co.	1 01
	N. Wonderly	4 90
	Studebaker & Co.	375 00
	J. Jingo	5 00
	Peter Fox	1 25
	Marco Varozza	11 90
	Frank Phelps	64 00
	Harry Phelps	10 00
	Marco Varozza	10 00
	Rico Varozza	20 00
	John Bassi	6 00
	Wm. Watson	7 50
	Watson Marks	22 00
	John Varozza	8 00
	Rico Varozza	10 00
	Notary fee	50
	Francis Frey	7 50
May 28—	J. S. Creighton	29 70
	Wm. Rust	50
	Thos. Alderson	68 81
	Ben Fossatti	1 20
	M. Dunkum	1 00
	Wm. Watson	75 00
	George Meyers	43 00
	George Hilbert	47 50
	Samuel Simone	32 00
	L. Biagotti	38 00
	John Bassi	50 00
	Gregorio Papini	39 00
	Watson Marks	189 00

1900		
May 28—	Rico Varozza	$77 50
	J. B. Varozza	112 00
	Marco Varozza	12 00
	Notary fee	50
Sept. 17—	Capitol Sewer Pipe W'ks	273 75
	Mountain Democrat	4 50
	Rico Varozza	67 50
	John Bassi	67 50
	J. B. Varozza	108 00
	V. J. Campini	10 00
	Wm. Watson	52 50
	Gregorio Papini	52 00
	Samuel Simone	52 00
	Lugi Biagotti	46 00
	John Hartman	38 00
	Watson Marks	168 00
	George Meyer	45 00
	Geo. H. Hilbert	42 00
	Francis Frey	24 00
	Marco Varozza	57 65
	Thos. Alderson	28 35
	Marks & Underwood	4 50
	Frank Phelps	24 00
	Orin C. Phelps	23 00
	Wm. Martin	40 00
	Rico Varozza	65 00
	J. B. Varozza	104 00
	John Bassi	65 00
	Wm. Watson	2 50
	V. J. Campini	52 00
	Gregorio Papini	52 00
	Samuel Simone	52 00
	John Hartman	52 00
	Lugi Biagotti	50 00
	Watson Marks	64 00
	Geo. Marquini	36 00
	D. E. Copple	8 00
	Marco Varozza	32 50
	Sunset Telephone Co.	3 30
	J. C. Stephens	6 00
	Thos. Alderson	13 35
	Rico Varozza	65 00
	John Bassi	65 00
	J. B. Varozza	104 00
	V. J. Campini	52 00
	Gregorio Papini	52 00
	Samuel Simone	52 00
	John Hartman	50 00
	Lugi Biagotti	52 00
	Geo. Marquini	50 00
	D. E. Copple	50 00
	Sunset Telephone Co.	3 60
	Marco Varozza	5 40
	Marco Varozza	19 50
	Thos. Alderson	13 50
	J. & J. Blair	14 45

FINANCIAL REPORT—LAKE TAHOE STATE ROAD—Continued.

1900			1900		
Sept. 17—	Francis Frey	$18 00	Sept. 17—	Francis Frey	$20 00
	F. Brown	5 50		Watson Marks	64 00
	R. G. Small	18 00	Sept. 5—	Marco Varozza (first payment on bridge)	6,244 00
	F. Brown	8 75			
	Francis Frey	30 00			

APPENDIX C.

EXPENDITURES FOR ROADS FROM 1898 TO 1900.

Counties.	1898–1899.	1899–1900.	Total.
Alameda	$61,954 23	$66,078 72	$128,032 95
Alpine	1,076 22	1,119 12	2,195 34
Amador	17,490 50	16,104 02	33,594 52
Butte	46,027 62	45,661 28	91,688 90
Calaveras	12,862 86	12,283 01	25,145 87
Colusa	27,353 89	30,974 80	58,328 69
Contra Costa	46,159 21	48,631 06	94,790 27
Del Norte	5,449 78	5,415 98	10,865 76
El Dorado	12,872 45	12,779 90	25,652 35
Fresno	48,483 58	60,427 26	108,910 84
Glenn	18,255 06	20,113 14	38,368 20
Humboldt	44,579 60	46,310 48	90,890 08
Inyo	2,971 38	3,367 54	6,338 92
Kern	24,303 00	26,269 65	50,572 65
Kings	10,713 04	10,760 33	21,473 37
Lake	12,473 08	12,857 72	25,330 80
Lassen	9,690 31	8,670 51	18,360 82
Los Angeles	99,994 48	123,057 21	223,051 69
Madera	13,188 07	19,747 64	32,935 71
Marin	18,677 40	20,889 55	39,566 95
Mariposa	6,130 83	7,061 28	13,192 11
Mendocino	28,624 81	32,361 96	60,986 77
Merced	27,715 47	29,149 20	56,864 67
Modoc	8,015 76	9,772 74	17,788 50
Mono	2,831 04	2,524 78	5,355 82
Monterey	32,084 06	47,814 38	79,898 44
Napa	22,205 64	21,737 44	43,943 08
Nevada	16,654 36	16,861 00	33,515 36
Orange	21,621 02	24,635 62	46,256 64
Placer	20,649 90	20,461 28	41,111 18
Plumas	8,751 88	12,132 82	20,884 70
Riverside	10,639 42	14,770 17	25,409 59
Sacramento	48,237 24	48,464 60	96,701 84
San Benito	12,046 92	11,541 35	23,588 27
San Bernardino	28,454 21	35,082 48	63,536 69
San Diego	27,114 21	32,883 02	59,997 23
San Francisco*	----------	----------	----------
San Joaquin	29,618 64	50,379 99	79,998 63
San Luis Obispo	24,519 19	36,235 41	60,754 60
San Mateo	62,580 96	69,660 36	132,241 32
Santa Barbara	28,153 98	33,298 25	61,452 23
Santa Clara	91,018 72	122,658 48	213,677 20
Santa Cruz	25,935 23	26,519 35	52,454 58
Shasta	15,070 72	16,598 25	31,668 97
Sierra	5,645 24	5,759 00	11,404 24
Siskiyou	16,247 08	23,118 28	39,365 36
Solano	35,546 84	48,187 96	83,734 80
Sonoma	59,110 80	68,137 80	127,247 88
Stanislaus	21,430 23	21,773 55	43,203 78
Sutter	10,873 05	10,287 53	21,160 58
Tehama	30,032 43	25,544 74	55,577 17
Trinity	4,318 96	4,404 46	8,723 42
Tulare	28,562 89	30,896 64	59,459 53
Tuolumne	14,601 96	16,508 31	31,110 27
Ventura	24,068 29	24,978 70	49,046 99
Yolo	41,147 17	32,126 43	73,273 60
Yuba	5,726 62	5,849 59	11,576 21
Totals	$1,430,560 81	$1,631,696 11	$3,062,256 92

*San Francisco: Incorporated as a city and county. No expenditures on roads.

APPENDIX D.

EXPENDITURES OF DEPARTMENT UP TO AND INCLUDING NOVEMBER, 1900.

1899		
Aug. 19—	Charles Prince	$30 00
Sept. 4—	R. O. Kimbrough	12 00
	Wells, Fargo & Co.	2 30
	Pacific Wheel and Carriage Works	37 40
	Sayre & Son	8 00
	J. C. Irvine & Co.	12 00
	Wyckoff, Seamans & Benedict	87 00
	Sunset Tel. & Tel. Co.	13 40
	Thomas Fox, P. M.	5 00
	Charles Prince	30 00
Oct. 31—	Charles Prince	60 00
Dec. 5—	Charles Prince	30 00
Dec. 12—	Western Union Tel. Co.	25
	W. K. Cothrin	6 20
	William Carragher	9 00
	Harry M. Bowman	20 00
	D. McKay	9 00
	Bolton & Strong	6 55
	Western Union Tel. Co.	2 82
	J. L. Maude	14 25
	C. J. DeMerritt	4 00
	Sunset Tel. & Tel. Co.	6 10
	Frank H. Wing	2 25
	Western Union Tel. Co.	1 32
	Wells, Fargo & Co.	2 10
	Whisky Hill Wells	4 50
	John T. Stoll	3 00
	Sunset Tel. & Tel. Co.	5 50
	Capital & Sac'to Transfer Co.	1 00
	Mason's Steam Laundry	4 50
	Western Union Tel. Co.	1 26
	Miller Bros.	25
	C. Suter	1 15
	Thomas Fox, P. M.	10 00
	Electrical Engineering Supply Co.	4 90
	J. A. Green	60
	D. McKay	10 00
	Sunset Tel. & Tel. Co.	5 50
	Western Union Tel. Co.	77
	Wells, Fargo & Co.	35
	Sunset Tel. & Tel. Co.	25
	Lodi Hotel	50
	Lodi Hotel	50

1899		
Dec. 12—	J. L. Maude	$2 85
1900.	J. L. Maude	2 85
Jan. 2—	Charles Prince	30 00
Feb. 1—	Charles Prince	30 00
Feb. 3—	Geo. H. Fuller Desk Co.	143 50
Feb. 8—	Fashion Stables	52 30
	A. Meister & Son	1 70
	John Breuner	4 50
	Fashion Stables	32 60
	Fashion Stables	19 35
	D. Johnston & Co.	1 70
	Dr. C. L. Megowen	5 00
	Fashion Stables	59 15
	Wells, Fargo & Co.	1 55
	Whisky Hill Wells	4 50
	W. K. Cothrin	8 45
	Western Union Tel. Co.	79
	Mason's Steam Laundry	4 50
	Wells, Fargo & Co.	1 35
	Southern Pacific Co.	50
	B. W. Lavell	25
	Palace Hotel	2 50
	C. W. Vickrey	10 15
	J. C. Irvine & Co.	10 00
	Southern Pacific Co.	50
	Sunset Tel. & Tel. Co.	45
	Western Union Tel. Co.	3 69
	Thomas Fox, P. M.	10 00
Mar. 1—	Charles Prince	30 00
Mar. 15—	Wyckoff, Seamans & Benedict	35 00
	J. L. Maude	5 10
	Sunset Tel. & Tel. Co.	5 50
	Dr. C. L. Megowen	2 50
	H. C. Carter	26 00
	Wells, Fargo & Co.	80
	Western Union Tel. Co.	3 29
	Sunset Tel. & Tel. Co.	7 25
	Fashion Stables	63 95
Apr. 4—	H. S. Crocker Co.	55
	W. F. Purnell	1 50
	Fashion Stables	15 80
	Whisky Hill Wells	4 50
	Western Union Tel. Co.	55
	W. F. Purnell	35
	Charles Prince	30 00
	Mason's Steam Laundry	4 50

EXPENDITURES OF DEPARTMENT—Continued.

1900		
Apr. 4	Sunset Tel. & Tel. Co.	$5 75
Apr. 20	Charles Prince	30 00
May 22	Charles Prince	30 00
June 4	Union Lithograph Co.	1 25
	R. O. Kimbrough	1 50
	R. O. Kimbrough	55
	H. J. Furley	10 00
	Wells, Fargo & Co.	45
	Sunset Telephone Co.	7 60
	J. O. Coleman, P. M.	10 00
	Wells, Fargo & Co.	10 15
	Western Union Tel. Co.	49
	Sunset Tel. & Tel. Co.	7 10
	John Breuner Co.	4 25
Aug. 7	Charles Prince	30 00
Aug. 17	Charles Prince	30 00
Aug. 31	Charles Prince	30 00
Sept. 24	Charles J. Noack	8 50
	J. L. Maude	35 25
	Hotel Arlington	8 00
	Sunset Telephone Co.	7 10
1900		
Sept. 24	John Breuner Co.	$10 00
	Mason's Steam Laundry	4 50
	Whisky Hill Wells	4 50
	Buffalo Brewing Co.	30
	Wells, Fargo & Co.	2 20
	Sunset Telephone Co.	4 65
	Sunset Telephone Co.	5 50
	Wells, Fargo & Co.	1 00
	Sunset Telephone Co.	5 95
	Western Union Tel. Co.	40
	J. O. Coleman, P. M.	5 00
	W. K. Cothrin	10 80
	Wells, Fargo & Co.	25
	Sunset Telephone Co.	9 80
	J. O. Coleman, P. M.	5 00
	Charles Prince	4 50
	Whisky Hill Water Co.	4 50
	Charles Prince	30 00
	D. McKay	10 00
	Western Union Tel. Co.	4 37

APPENDIX E.

EXPENDITURES FROM TIOGA FUND.

1899			
Sept. 5—	Henry Kahn & Co.	$58	00
	John R. Carr	42	05
	P. C. Johnson & Co.	21	00
	Hall, Luhrs & Co.	52	45
	Kirk, Geary & Co.	116	70
	Holbrook, Merrill & Stetson	9	00
	Wawona Hotel Co.	37	61
	U. S. Q. M. Dept.	12	35
Oct. 31—	Paul Renie	80	00
	Henry Carter	98	65
Dec. 14—	Locke & Lavenson	15	50
	Rafael, Weil & Co.	13	10
	Nevill & Co.	4	50
	Clabrough-Golcher Co.	8	00
	John Breuner Co.	82	89
	Southern Pacific Co.	49	02
	Weinstock, Lubin & Co.		60
	J. C. Johnson & Co.	25	00
	Shaw Bros.	1	10
	Holbrook, Merrill & Stetson	9	00
	Rosenwald, Kahn & Co.	2	62
	John R. Kerr	54	50
	Wells, Fargo & Co.	8	25
	George Fisk	50	00
	Sentinel Hotel	4	50
	John Trabucco	7	15
	Mariposa Hotel	5	50
	John Trabucco		75
	The New Market	1	60
	Mrs. R. W. Greeley	25	00
	The Wawona Hotel Co.	46	45
	Yosemite Stage and Turnpike Co.	110	49
	A. F. Bruce	4	60
	Yosemite Stage and Turnpike Co.	5	30
	Yosemite Falls store	2	20
	James Halsted	18	85
	W. H. Dudley	6	50
	Percy Davis	4	15
	G. W. Hammell		75
	W. A. Sale	1	35
	J. P. F. Murray	1	00
	L. Boyle & Son	1	25
	Hammon & Bates		55
	Mrs. N. H. Tull	3	10
1899			
Dec. 14—	Phœnix Livery and Feed Stable	$4	50
	Galt Hotel	4	50
	Southern Pacific Co.	12	13
	Stephen Butler, Jr.	2	00
1900.	D. Johnston & Co.	1	70
Mar. 16—	J. L. Maude	6	35
	Hotel St. Nicholas	18	00
	Palace Restaurant	10	00
	Mrs. Irvine	48	00
	John Breuner Co.	19	64
	A. Leitz Co.	194	20
June 4—	Fashion Stables	15	00
	Fred I. Monson	307	52
	H. J. Furley	35	00
	W. P. Fuller & Co.	10	00
	George B. Stack	18	00
	H. J. Furley	20	00
	A. Leitz Co.	27	75
	H. S. Crocker Co.	87	40
	John Breuner	24	50
	Nevill & Co.	165	30
	Max Eichrodt	4	92
	Holbrook, Merrill & Stetson	25	00
	Southern Pacific Co.		50
	Schaw, Ingram, Batcher & Co.	31	40
	John Breuner Co.	26	25
	Holbrook, Merrill & Stetson	3	00
	C. Suter	2	40
	M. J. Bannon	1	75
	Southern Pacific Co.	1	03
	J. A. Green	19	80
	Capital & Sac'to Transfer Co.	1	75
	R. O. Kimbrough		15
	Lindley & Co.	265	91
	Kimball & Upson	10	80
	Jacox Bros.	5	00
	John T. Stoll	9	60
	Weinstock, Lubin & Co.	71	50
	Capital & Sac'to Transfer Co.	3	00
	Wassermann, Kaufmann & Co.	2	94
	Kirk, Geary & Co.	28	95

EXPENDITURES FROM TIOGA FUND—Continued.

1900		
June 4—	Southern Pacific Co.	$112 80
	Fashion Stables	83 15
	Richard Happ	2 50
	H. Turner	7 20
	D. McDougall	135 00
	J. L. Maude	294 80
Aug. 7—	L. A. Wallace	80 00
Aug. 16—	John T. Stoll	135 25
	C. W. Lamphrey	80 00
Sept. 24—	J. L. Maude	4 40
	A. Leitz Co.	3 50
	Kirk, Geary & Co.	9 60
	C. L. Megowen	10 00
	D. McKay	12 00
	Carey House	3 00
	J. C. Stephens	9 30
	Southern Pacific Co.	8 46
	Southern Pacific Co.	1 43
	Francis Frey	9 00
	Wm. Martin	2 25
	Lakeside House	8 00
	The Latest	2 50
	Chris Neilson	1 25
	Richard Bartels	7 25
	Fred Hardy	3 50
	D. Hayes & Bro.	2 25
	A. D. Waltze	4 00
	H. L. Leavitt	3 00
	E. Pierson	3 00
	W. E. Reading	1 25
	Harvey Boone	10 60
	Occidental Hotel	2 75
	P. G. Hughes	2 50
	G. W. Vansickle	75
	H. L. Leavitt	8 00
	A. D. Waltze	7 00
	Sentinel Hotel	18 00
	Kaufmann & Kenney	37 00
	H. W. Nelson	3 50
	G. W. Vansickle	75
	D. Hayes & Bro.	65
	A. D. Waltze	2 75
	Leavitt House	2 00
	Bodie Ry. & Lumber Co.	18 60
	A. Leitz Co.	13 00
	Sentinel Hotel	5 25
	Sentinel Hotel	15 75
	J. Bauquier	4 00
	Robert Murray	16 50
	D. McKay	5 00
1900		
Sept. 24—	Sentinel Hotel	$3 00
	Kaufmann & Kenney	12 00
	Kaufmann & Kenney	45 00
	J. P. Hammond	10 00
	P. Sislini	17 00
	W. P. Campbell	23 50
	D. W. Hayes	133 35
	Sentinel Hotel	22 50
	John McCauley	1 75
	Hale Bros.	07
	Adam Farrington	512 50
	W. J. Farrington	130 00
	Jesus Cruz	120 00
	Adam Farrington	53 05
	Bodie Toll-Road	25
	A. D. Waltze	3 00
	P. G. Hughes	5 00
	Mrs. T. C. Sharp	2 50
	Fred Hardy	1 00
	H. L. Leavitt	3 00
	Nucleus Hotel	2 00
	Fred Steinman	1 00
	W. Radley	4 00
	Mrs. H. W. Jones	6 00
	Kimball & Upson	4 45
	C. H. Parish	1 00
	L. H. Pratt	1 00
	A. J. Celio	7 00
	Hale Bros.	25
	F. C. Frey	9 50
	Larkin Bros.	2 00
	Mrs. L. Fauret	1 00
	Mrs. A. Naugley	50
	Marks & Woodward	4 00
	Alden & Campini	65
	Southern Pacific Co.	52 92
	Leo Solomon	122 65
	Capital and Sacramento Transfer Co.	3 00
	John T. Stoll	2 75
	Harold J. Furley	525 00
	Victor Noble	160 00
	Henry Carter	135 00
	C. W. Vickrey	24 00
	H. S. Crocker Co.	20
	T. W. McAuliffe & Co.	60
	H. J. Furley	31 05
	G. R. Gross	165 00
	J. L. Maude	186 70
	Wawona Hotel Co.	23 00

APPENDIX F.

EXPENDITURES FROM LAKE TAHOE WAGON ROAD FUND.

1900		
Mar. 16	J. H. Zimmermann	$6 00
	The Carey House	10 00
	A. Leitz Co.	273 00
	Hotel St. Nicholas	30 70
	J. L. Maude	14 75
June 4	J. H. Zimmerman	7 50
	Marks & Woodward	16 00
	Francis Frey	30 00
	The Carey House	6 00
	J. L. Maude	32 25
	W. F. Purnell	2 00
	H. S. Crocker Co.	14 60
	Fashion Stables	31 30
	Robert Kirk	215 65
	Wm. H. Wheeler	50 00
	Western Union Tel. Co.	45
	Harlow Bros.	6 00
	The Bee	16 90
1900		
June 4	Record-Union	$20 00
	C. Suter	15 30
	State Prison, Folsom	275 00
	David Megowen	28 80
	Southern Pacific Co.	76
	Fairbanks, Morse & Co.	119 00
	Thomas Fraser	2 00
	H. J. Furley	10 00
Aug. 16	J. M. Miller	680 00
Sept. 24	A. Leitz Co.	15 00
	J. F. Hill Carriage Works	17 00
	The Ohio House	2 00
	Marks & Woodward	16 00
	Baker & Hamilton	97 00
	A. Leitz Co.	30 00
	Kimball & Upson	6 80
	J. L. Maude	41 45
Oct. 5	J. M. Miller	570 00

INDEX.

A

PAGE.

Abundance of road material in California ... 46
Administration of roads in foreign countries ... 28
Administration of roads in other States ... 14
Advantages of good roads ... 37
Advice to be furnished counties ... 73
Alabama, Road administration in ... 14
Arkansas, Road administration in ... 14
Austria, Road administration in ... 28
Ancient roads ... 5
Appendix A—Yosemite Commission Report ... 79
Appendix B—Tahoe Commissioner's Report ... 105
Appendix C—Road Expenditures in California ... 111
Appendix D—Expenditures of Department ... 112
Appendix E—Tioga Road Fund Expenditures ... 114
Appendix F—Lake Tahoe Road Fund Expenditures ... 116

B

Bakersfield-Santa Barbara road ... 76
Belgium, Road administration in ... 29
Big Oak Flat road ... 81
Big Tree branch of Yosemite Road ... 88
Bloody Cañon route, Yosemite ... 94
Bonding laws, Amendments to ... 75
Bridges ... 57

C

Calhoun, John C., road bill ... 11
California, Conditions in ... 6
  Expenditures for roads in ... 6
  Road-building material in ... 46
Chartered turnpike companies ... 9
Chinquapin road ... 88
Colorado, Road administration in ... 14
Connecticut, Road administration in ... 14
Construction and maintenance of roads ... 43
Convexity of roadbed ... 48
Convict labor on roads ... 61
Cost of roads, France ... 30
  Massachusetts ... 19
  New Jersey ... 22
  Oregon ... 24
Crown of roadbed ... 48
Culverts ... 57
Cumberland road ... 11

D

Delaware, Road administration in ... 15
Dirt roads ... 49
Drainage of roads ... 44
Drains. *See* Culverts.

E PAGE.

Egyptian roads 5
England and Wales, Road administration in 35
Expenditures on roads in California 111

F

Financial report, Department of Highways 112
  Lake Tahoe Road Commissioner 116
Florida, Road administration in 15
Folsom rock-crushing plant 63
France, Road administration in 29

G

Georgia, Road administration in 15
Germany, Road administration in 30
Grades of roads 43
Graders, Road 59
Gravel roads 52
Great Sierra Wagon Road. *See* Tioga Road.
Greece, Roads in 5

H

Henry, Patrick, letter to 9
Hetch Hetchy Valley road 95
Highway Commissions 37
  Connecticut 14
  Massachusetts 19
  New Jersey 22
  New York 23
  Rhode Island 25
  Vermont 26
Humboldt-Shasta road 77

I

Idaho, Road administration in 16
Illinois, Road administration in 16
Incas, Roads of 5
Indiana, Road administration in 16
Introductory 5
Iowa, Road administration in 17
Ireland, Road administration in 36
Israelite roads 5
Italy, Road administration in 32

K

Kansas, Road administration in 17
Kentucky, Road administration in 17

L

Lake Tahoe State Wagon Road. *See* Tahoe Road.
Layers of surfacing material, thickness of 52
Legislation in other States 14
Letter of Transmittal 3
Levining Creek route 93
Location of roads 43
Los Angeles-Kern County road 77
Louisiana, Road administration in 18

M	PAGE.
Macadam roads	49
Machinery, Road	59, 74
Maine, Road administration in	18
Maintenance of roads	43
Maps, Road	60, 77
Mariposa road	87
Maryland, Road administration in	18
Maryland Geological Survey	18
Massachusetts, Road administration in	19
Michigan, Road administration in	20
Milestones	58
Mill Creek road	91
Minnesota, Road administration in	20
Mississippi, Road administration in	21
Missouri, Road administration in	21
Montana, Road administration in	21
Moore, W. H.	39
N	
National Highways of United States	12
National Highway Commission	13
National Parks	78
Nebraska, Road administration in	21
Nevada, Road administration in	22
New Hampshire, Road administration in	22
New Jersey, Road administration in	22
New York, Road administration in	23
North Carolina, Road administration in	23
North Dakota, Road administration in	24
O	
Office of Road Inquiry, Department of Agriculture	14
Ohio, Road administration in	24
Oil, Use of on roads	54
Old York road	8
Oregon, Road administration in	24
P	
Peru, Roads of ancient	5
Philadelphia-Lancaster pike	10
Pipe-drains and culverts	57
Powers of Highway Commissioner	74
R	
Railroads, Letters from officials of	39
Recommendations of Department	73
Records, Road	60
Report of Yosemite Road Commission	79
Report of Lake Tahoe Road Commissioner	105
Rhode Island, Road administration in	25
Road machinery	59
Road material in California	46
Rock-crushers	60
Rollers, Road	59
S	
Sacramento-Yolo road	77
Santa Barbara-Bakersfield road	76
Scotland, Road administration in	35

PAGE.
Shasta-Humboldt road 77
Signboards 58
South Carolina, Road administration in 25
South Dakota, Road administration in 25
Spain, Road administration in 33
Sprinkling with water 53
Sprinkling with oil 54
State aid, Necessity for 76
State Highway Commissions 37
Stone roads 49
Structures, Road 57
Switzerland, Road administration in 33

T

Tables, Grades and hauls 66, 67
  Road material in California 46
Tahoe road 72
  Report of Commissioner 105
Tallac-McKinney's road 78
Tejon Pass road 77
Telford road 53
Tenaiya Cañon road 71, 96
Tennessee, Road administration in 26
Texas, Road administration in 26
Thickness of layers of surfacing material 52
Tioga road 69, 89
Tires. *See* Wide Tires, Traction Tests, Etc.
Toll roads 28, 30, 35
Traction tests 64
Traffic on roads 67
Tree-planting 32
Turnpikes 9

U

United Kingdom, Road administration in 35
United States, Roads in 7
Utah, Road administration in 26

V

Vermont, Road administration in 26
Virginia, Road administration in 27

W

Washington, George, letter of 9
Washington, Road administration in 27
Wawona toll road 85
West Virginia, Road administration in 27
Wide tires 65
Wide-tire laws 54
Width of roads 48
Wisconsin, Road administration in 27
Wyoming, Road administration in 27
Work of Department 69

Y

Yosemite National Park, Report of Commission 79

91